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June 15, 1990

Energy Research Abstracts

Abstracts 25255–27386

Office of Scientific and Technical Information
UNITED STATES DEPARTMENT OF ENERGY

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Energy Research Abstracts

Purpose

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U.S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. Foreign information is obtained through the International Energy Agency's 14-nation Energy Technology Data Exchange, the International Atomic Energy Agency's International Nuclear Information System, or nation-to-nation agreements. **Please note that *ERA* coverage of nonreport literature is limited to that generated by Department of Energy activity.**

Scope

ERA is comprehensive in its subject scope, encompassing DOE's research, development, demonstration, and technological programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

The citations presented in *ERA* are available for online searching as records within the Energy Data Base. The current-year records are available on the Integrated Technical Information System (ITIS). The entire database is available through commercial online vendors.

Availability

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Managing Editor, Audrey B. Smith
Technical Editor, Robert W. Rutkowski

Information Sources

The citations presented in *Energy Research Abstracts* are a subset of the worldwide energy information provided to the Office of Scientific and Technical Information (OSTI) through exchange agreements with foreign sources and through exchanges or contracts with U.S. organizations.

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1. **Abstract number** within volume.
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3. **Title and subtitle** (non-English title may appear in parentheses, if applicable).
4. **Author(s).** First 10 names in the data record are printed, then "et al." is listed.
5. **Author affiliation.** Only first one is listed, in parentheses after author(s) to which it applies.
6. **Collaboration,** if present.
7. **Corporate author(s)** identifying corporation responsible for document.
8. **Patent assignee and number** for citations of patent documents or applications.
9. **Journal title, volume, and issue** for citations of journal articles.
10. **Date of publication.** If not known, a processing date is in brackets.
11. **Number of pages** or page range.
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13. **Monograph title** if citation is an analytic (part, chapter, or paper) of a larger monograph.
14. **Publisher's name and location** for documents published by a corporate or commercial source.
15. **Sponsoring organization.**
16. **Contract or grant number.**
17. **Secondary identifying number;** may be a conference number.
18. **Conference title, location, and date,** if applicable.
19. **Order number.** The "DE" order number may be used for ordering from NTIS or OSTI, as appropriate. The "TI" prefix is valid only at OSTI.
20. **Sources of availability** from which a copy of the document may be obtained; usually appear as abbreviations. (See information on following page.)
21. **Drop note** or explanatory statement.
22. **Abstract.**
23. **Subject descriptors.** Listed only if no abstract or only a brief statement is included.

Sample Citations

Report

18494 (DOE/ER/40438–T1) **[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report.** Haeberli, W. Phys. VI collaboration. Wisconsin Univ., Madison (USA). Dept. of Physics. [1989]. 12p. Sponsored by DOE Energy Research. DOE Contract FG02-88ER40438. Order Number DE89007246. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper briefly discusses the Wisconsin test facility for storage cells; results of target tests; the new UHV...

Report Analytic

18500 (INIS-SU—69, pp. 30-32) **Transition energies in Ne-like ions. Correlation effects.** Vainshtejn, L.A. AN SSSR, Moscow. Fizicheskij Inst. 1988. (In Russian). In *Experimental and theoretical physics. Collection.* Order Number DE89780060. Available from NTIS (US Sales Only), PC A03/MF A01; INIS.

Kratkie Soobshcheniya po Fizike.; no. 6.

SILVER IONS/energy-level transitions; XENON IONS/energy-level transitions; CORRELATIONS; D STATES; E STATES;...

Journal Article

19055 **A theoretical and experimental investigation of long-pulse, electron-beam-produced rare gas plasmas.** Brake, M.L.; Repetti, T.E. (Energy Beam Interaction Lab. of the Dept. of Nuclear Engineering, Univ. of Michigan, Ann Arbor, MI (US)). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA),* 16(5): 581-589 (Oct 1988). (CONF-881020–: Symposium on radiation physics, Sao Paulo, Brazil, October 3, 1988).

Visible emission spectroscopy (380-650 nm) has been performed on intense, electron beam (1 kA, 300 ns, 300 kV) produced Ar, Kr,...

Patent

18045 **Polarization of fast particle beams by collisional pumping.** Stearns, J.W. To Dept. of Energy, Washington, DC. USA Patent 4,724,117. 9 Feb 1988. Filed date 19 Oct 1984. vp. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

A method for polarizing a fast beam of particles by collisional pumping, comprising the steps of generating a beam...

How To Order from the Availability Sources

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Report literature, usually identified by an alphanumeric identifier at the beginning of a citation, is available from the sources listed in the citation (see example of element 20 on page iii). Often the sources are listed as abbreviations. Corresponding addresses are provided at right from which documents with these abbreviations may be ordered. When "OSTI" is given, **DOE and DOE contractors may order these documents from OSTI.** (However, check with your library or information organization which may require that orders go through them to OSTI.) The public should order from NTIS or from one of the other agencies listed in the citation. To expedite processing, an order form is provided in the back of this publication. NOTE: The order numbers provide quicker access for report ordering. Use the order number where possible.

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Journal articles *Chemical Abstracts Service Source Index (CASSI)* tells which libraries, both U.S. and foreign, contain a journal and the available years. *Ulrich's International Periodicals Directory* contains information on the journal and its publisher. For librarians, another source of information is On-Line Computer Library Center (OCLC), for interlibrary loans.

Books, conferences, and monographs The source for these publications is the publisher or the originating society, organization, or institution. DOE-supported conferences and individual papers reporting DOE-supported research may be available as reports from OSTI.

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National Translation Center
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United Kingdom

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Five indexes are provided for approaching the content of each issue of *Energy Research Abstracts.* Descriptions of entries in these indexes follow.

Corporate Author Index
The corporation, organization, or institution responsible for the issuance of the document is listed in this index. The entries are arranged alphabetically and provide the title and citation number of the reference. For example, the listing for the "Report" sample citation would appear as shown at right.

Wisconsin Univ., Madison (USA). Dept. of Physics
[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)
Wisconsin Univ., Madison (USA). Lab. of Genetics
Organization of the R chromosome region in maize: Final progress report, June 1, 1983–May 31, 1986, 15:18255 (R;US)

Personal Author Index
Each author's name listed on a document cited in this issue is indexed. An index entry provides title and citation number; for secondary and other names, a cross-reference is given to the primary author name where the full index entry is located.

Hadley, D.L., *See* Lee, A.D., 15:17651
Haeberli, W., [Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)

Subject Index
This index lists the main subject descriptors assigned to each record by indexing professionals. A secondary or qualifier term is used where necessary to describe materials, objects, and processes. Document titles may be enhanced with additional informative phrases where necessary. An excerpt from this index appears at right.

HYDROGEN ISOTOPES
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TRITIUM
Neutron-Rich Isotopes
Study on the strong neutron-rich nuclei of lightest elements, 15:18686 (RA;SU;In Russian)

Contract Number Index
DOE technical reports are listed by contract number. Each entry also provides the primary corporation or organization cited for that contract number. A typical entry is shown.

FG02-88ER40438 **Wisconsin Univ., Madison (USA). Dept. of Physics**
15:18494 DOE/ER/40438–T1
FG02-88ER60664 **Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)**
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Report Number Index
Technical report literature is indexed by the alphanumerical identifier of the report. Patent documents and conferences are included for convenience. Each entry lists the citation number, the source of availability of the document, an indicator of presence at a GPO depository library, order number, and distribution category. A typical entry is:

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T1 15:18494 NTIS, PC A03/MF A01 - OSTI E 1.99: DE89007246 MF-411

Subject Contents

The subject content of *Energy Research Abstracts* is arranged as shown below. The two-digit and four-digit category numbers printed here illustrate the category number assignment used in the database records.* The following list includes all of the 39 first-level and the 308 second-level categories. Because each issue of *ERA* publishes citations only for those documents announced during the past semimonthly period, some subject categories may not be present in every issue.

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*The numerical subject category scheme is used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's data systems. Categories and definitions for the complete set of six-digit numbers are given in DOE/TIC-4584, *Energy Data Base: Subject Categories and Scope*.

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Energy Research Abstracts

01 COAL, LIGNITE, AND PEAT

Refer also to citation(s) 26373

0103 Preparation

Refer also to citation(s) 25289, 25309, 25691

25255 (ERP/CRL–86-127(CF)) **Petrographic characterization of thickener feed samples.** Munoz, V.A. Canada Centre for Mineral and Energy Technology, Edmonton, AB (Canada). Fuel Research Lab. Nov 1988. 20p. Available from Canada Centre for Mineral and Energy Technology, Edmonton, AB (Canada). Fuel Research Lab.

The objective of this study was to provide a better understanding of washery thickener feed samples with respect to water clarification. Conventional thickener feed samples from the Cardinal River coal mine, Alberta, are examined and compared. A petrographic analysis was performed on three samples to provide information as to factors responsible for differences in their responses to flocculation. The results show that the sample having the most problematic characteristics during flocculation exhibited the highest degree of degradation of the coal particles which were in intimate association with the minerals. 1 tab., 13 figs.

25256 (ERP/CRL–89-47(TR)) **Coal preparation issues.** Hazma, H.A. Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Fuel Processing Lab. May 1989. 24p. Available from Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Fuel Processing Lab.

One of the difficulties shared by coal preparation facilities and mineral processors is the treatment of fine particles. This paper briefly examines the importance of fine particle R & D to the mineral and energy industries. Examples of past and present solutions to the the problem are given. 9 figs., 1 tab.

0104 Processing

Refer also to citation(s) 25382, 25638, 25639, 26373

25257 (CONF-890884–) **Bioprocessing of fossil fuels workshop: Proceedings.** Bayer, P.E. (ed.) (Energetics, Inc., Columbia, MD (USA)). USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA); Idaho National Engineering Lab., Idaho Falls, ID (USA). Center for Bioprocessing Technology. [1989]. 493p. Sponsored by U.S. DOE Fossil Energy. From Bioprocessing of fossil fuels workshop; Tysons Corner, VA (USA); 8-10 Aug 1989. Order Number DE90007955. Available from NTIS, PC A22/MF A01 - OSTI; GPO Dep.

Research programs from the workshop on the bioprocessing of fossil fuels, are presented. Reports were presented under the following topics: coal desulfurization; microbial deashing; european projects; bioreactor technology; molecular biology and enzymology; microbial solubilization of coal; and bioprocessing of petroleum derived materials. Individual projects are processed separately for the data bases. (CBS)

25258 (DOE/MC/22062–2791-Vol.1) **Modeling hydrodynamic mixing in process design and development of fluidized bed gasifiers: Volume 1: Final report.** Blake, T.R.; Richner, D.W. Massachusetts Univ., Amherst, MA (USA). Dept. of Mechanical Engineering. Dec 1989. 78p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-85MC22062. Order Number DE90000444. Available from NTIS, PC A05/MF A01 - OSTI.

This report presents a summary of the work accomplished in a multiyear study conducted for the US Department of Energy, Morgantown, Energy Technology Center, under Contract No. AC21-85MC220262. In this project existing models for hydrodynamic mixing in fluidized beds are used in a representative process design and development scenario for the KRW gasifier. The particular emphasis in this study is upon the use of two modeling approaches: the dimensional analysis and scaling of fluidization data, and the application of the finite difference hydrodynamic model CHEMFLUB. Predictions of hydrodynamic mixing in the KRW reactor are made. The relative value and practicality of the two different models for predicting hydrodynamic mixing are assessed through comparisons with experimental data. 75 refs., 29 figs., 9 tabs.

25259 (DOE/METC–88/6098, pp. 99-104) **Mild gasification: Product characterization.** Graves, R.L. (Oak Ridge National Lab., TN (USA)); Daw, C.S. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The purpose of this investigation is to evaluate the products of mild gasification to provide data which can be used in systems studies of the relationships between process conditions, product yields, and the product quality. Of particular interest is whether the co-products from mild gasification are of suitable quality to be used as fuels with little or no upgrading. The principal application of the oil product is as a diesel engine fuel, and the char will be studied mainly as a boiler fuel candidate. The paper describes procedures which will be used for liquid and char characterizations. The status of sample acquisitions and preparations for combustion characterizations are discussed.

25260 (DOE/METC–88/6098, pp. 114-123) **Upgrading of condensibles from coal devolatilization.** Mrochek, J.E. (Oak Ridge National Lab., TN (USA)); Scott, C.D. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The emphasis of this work is on the development of cost-effective upgrading methodologies based on solvent extraction using high-efficiency contactors. Initial emphasis is on the removal of organo-nitrogen compounds since they tend to poison catalysts, are hazardous to human health, and are generally the most difficult to remove by more conventional upgrading methods. Extraction studies are described which were performed on UCCRC condensibles, SGI condensibles, and a Kilngas condensible. The conclusions that can be drawn from solvent extraction studies on limited amounts of three condensible liquids must be tentative. However, it appears that incomplete separation of the aqueous phase and poor extraction of the nitrogen-containing contaminants from the condensible liquids produced by UCCRC can be alleviated by distillation of the raw condensible liquids. Distillation is recommended as the first step in an upgrading process that incorporates solvent extraction for nitrogen removal. Based on the present state of knowledge concerning cost, efficiency, availability, and materials of construction, 75 vol % acetic acid is recommended as the extraction medium. However, to be economically feasible, a solvent-reagent regeneration stages and these have not been defined at the present stage of this project.

25261 (DOE/METC–88/6098, pp. 124-133) **Advanced fuels research.** Smith, E.B. (Western Research Institute, Univ. Station, Laramie, WY (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the*

third annual oil shale, tar sand, and mild gasification contractors review meeting. Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The overall objective of this work is to evaluate mild gasification coal liquids, shale oil(s), or tar sand oil as sources for advanced fuels, especially military aircraft turbine fuels. Other objectives are (1) to explore processes other than hydrogenation for removing undesirable fuel components from the crude oils and (2) to prepare candidate aviation turbine fuels by the most promising processes steps, including hydroprocessing if necessary. Processes considered in the experimental plan are (besides distillation), dewaxing, acid/base extraction, coking, and RF heating. Three liquid by-products of lignite gasification were evaluated as sources of military jet fuels. The source of the by-products is the Great Plains Gasification Project (GPGP) near Beulah, North Dakota. These liquids are currently burned for steam generation. Results so far include: preparing candidate jet fuels from a coal-derived liquid; demonstrating that hydrogenation of phenols is wasteful; and showing that coal-derived light naphtha has potential for the production of a candidate endothermic fuel mixture or a high quality gasoline blending component.

25262 (DOE/METC–89/6099, pp. 184-193) **Study of ammonia removal in coal gasification processes.** Krishnan, G.N. (SRI International, Menlo Park, CA (USA)); Wood, B.J.; McCarty, J.G. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objective of this program is to identify and study a most promising process concept that can eliminate 90% of fuel-bound nitrogen from coal gas in a temperature range of 550 to 900 C. Ammonia is the major gaseous product of fuel-bound nitrogen produced by gasification of bituminous coals. The program is divided into three tasks: Comprehensive review of literature (completed); development of an experimental test plan (completed); and catalyst testing (in progress). Several catalysts were selected for experimental testing under laboratory-scale conditions. The selection criteria included high catalytic activity, tolerance to sulfur poisoning, resistance to degradation under high steam concentrations, and physical stability. The selected catalysts include: Ni-based catalysts on a proprietary ceramic support; Ni-based catalysts with CaO-stabilized alumina as the support; Zinc ferrite sorbents that contained NiO or CuO additives; and a MoS_2-based methanation catalyst. Available results are discussed.

25263 (DOE/METC–89/6099, pp. 194-203) **Ammonia removal in coal gasification processes using integrated systems approach.** Unnasch, S. (Acurex Corporation, Mountain View, CA (USA)); Chang, R. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The purpose of this project was to investigate process concepts to eliminate NO_x formation from fuel-bound nitrogen, primarily ammonia, in the gas stream from a coal gasifier at 1000 to 1600 F; to review all previous experimentation; and, to test the most promising approach to reduce the formation of NO_x to achieve environmentally acceptable levels. Staged combustion was tested under simulated hot coal gas conditions. Catalytic dissociation was also tested as an ammonia removal approach for comparison to staging. The results of this program have demonstrated the effectiveness of staged combustion in controlling NO_x emissions from gasifier gases containing ammonia. Staged combustion produced a minimum NO_x level of 50 ppm (corrected to 15 % O_2) at about 70 % theoretical air for the fixed-bed gas and 50 ppm at 50 % theoretical air for the entrained-bed gas. Ammonia conversion to NO_x was less than 5 % at the minimum NO_x condition. With both gas compositions, NO_x emissions asymptotically leveled off at high inlet ammonia levels. Upstream ammonia removal systems may not be needed to meet environmental constraints. At ammonia levels above 1000 to 2000 ppm, emissions with staging reached asymptotic levels, so additional upstream removal would be minimally effective. Catalytic dissociation can augment NO_x reductions from staged combustion and reduce combustor volumes for a given emissions target.

25264 (DOE/METC–89/6099, pp. 217-228) **Electrochemical abatement of pollutants NO_x and SO_x in combustion exhaust gases employing a solid-oxide electrolyte.** Mason, D.M. (Stanford Univ., CA (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objective of this contract is to test the feasibility of eliminating the pollutant species NO and SO_2 in combustion exhaust gases by pumping off oxygen employing a dry solid-oxide, oxygen-ion type electrolyte system. At the same time to conserve electrical power for pumping it is desirable not to have to pump off any unreacted O_2 that may remain in the exhaust gases. The applications in mind are treating exhaust gases from such devices as internal combustion engines, gas turbines and power-plant flue gases in the 400-700 C temperature range as well as the cleanup of high pressure, combustion gas prior to entering a gas turbine in the 700-1000 C temperature range. In optimizing the design of an electrochemical pollution-abatement reactor it is necessary to have a quantitative understanding of the basic chemical processes occurring in the system. To this end, a study of the effect that electrode morphology, electronic defect population as well as electrolyte composition has on electrocatalytic reaction-rates is being undertaken. The precise nature of the electrocatalytic role played by electronic defects, such as F-centers, is being elucidated. Available results are described.

25265 (DOE/METC–89/6099, pp. 241-245) **Bench-scale tests of alkali vapor removal from PFBC [pressurized fluidized bed combustion] exhaust using a fixed bed of activated bauxite sorbent.** Lee, S.H.D. (Argonne National Laboratory, IL (USA)); Carls, E.L. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

Vapor-phase alkalis present in the hot exhaust from PFBC are expected to penetrate through a particulate-removal device. These alkalis could cause corrosion of the PFBC gas turbine. A fixed granular-bed sorber is being developed at Argonne National Laboratory (ANL) for the control of the alkali vapor in PFBC exhaust. After an extensive screening study, activated bauxite was found to be the most effective sorbent in capturing NaCl, KCl, and K_2SO_4 vapors that were doped into a simulated PFBC gas stream. Activated bauxite was also demonstrated to be easily and effectively regenerated for reuse by a simple water-leaching process. The effectiveness of activated bauxite for alkali-vapor capture has been confirmed by others. During this reporting period, tests with the PFBC/alkali sorber unit were conducted to establish a reliable sampling technique for alkali-vapor measurement and to quantify the level of alkali vapors in the PFBC exhaust. Results of these two tests are presented.

25266 (DOE/METC–89/6099, pp. 252-261) **Integrated low emissions cleanup system for direct coal-fueled turbines - moving-fluid bed contactors/ceramic filters.** Newby, R.A. (Westinghouse Electric Corporation, Pittsburgh, PA (USA)); Alvin, M.A.; Bachovchin, D.M.; D'Amico, N.; Yang, W.C.; Smeltzer, E.E. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objective of this program is to demonstrate the conceptual feasibility of two advanced, high-temperature gas cleaning concepts for direct coal-fired turbines: a moving bed contactor coupled with high-temperature barrier filters, and a fluidized-bed contactor with integral high-temperature barrier filters. These are compact devices that perform simultaneous sulfur removal, alkali removal, and particulate removal. Five laboratory test efforts have been identified to be performed in Phase 1. They are: Hydrodynamic Modeling; Sulfur Removal; Alkali Removal; Combined Sulfur-Alkali Removal; and Coal-Ash/Sorbent Behavior. These tests support the bench-scale testing to be performed in Phase 3, providing the design basis for the bench-scale equipment and producing preliminary criteria for commercial equipment design. Preliminary results from all five studies are discussed.

25267 (DOE/METC–89/6099, pp. 262-268) **Integrated low emissions cleanup system for direct coal-fueled turbines (electrochemical reactor) - Phase I.** Siwajek, L.A. (Helipump Corporation, Cleveland, OH (USA)); Gordon, A.Z. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objective of this project is to develop means for the effective reduction of NO_x/SO_2 in direct coal-fueled turbines. The technology will utilize a solid oxygen ion conductive ceramic to disassociate NO_x/SO_2 molecules into their elemental constituents. An analysis of the integrated unit with particulate removal, NO_x/SO_2 reduction and turbine will be performed, as well as an economic evaluation. Phase I of this project concerns itself predominantly with the selection of optimal materials to be used as electrolyte, electrode and electrocatalyst for the reduction of NO_x/SO_2. The experimental apparatus will be a bench scale reactor which will operate between 1600 and 2500 F at one atmosphere total pressure. No results are available as yet.

25268 (DOE/METC–89/6099, pp. 269-278) **Electrostatic agglomeration for particulate control after sorbent injection.** Feldman, P.L. (Cottrell Environmental Sciences, Somerville, NJ (USA)); Kumar, K.S.; Bannister, R.L.; Diehl, R.C. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objective of this contract is to investigate the removal of SO_x and particulate matter from direct coal-fired combustion gas streams at high temperature and high pressure conditions. This investigation will be accomplished through a bench-scale testing and evaluation program employing the sorbent injection technique for SO_x removal, and an innovative particulate control concept that utilizes electrostatic agglomeration followed by a high efficiency, Van Tongeren type mechanical collector. The process goal is to achieve particulate collection efficiency better than that required by the 1979 new source performance standards. An additional goal is to demonstrate 70-90% SO_x removal efficiency by sorbent injection near the discharge zone of the combustor. The progress under this contract has been in Phase I - cleanup system design and preliminary evaluation. Specific results to date have been in the development of system specification and agglomerator sizing. Presently the focus is on the choice of materials for the internals of cleanup system. Materials such as silicon carbide are being researched for fabricability, and ease of changeout, etc. Methods of dust/slag removal from ESA are also being considered because of the potential for stickiness at the direct coal fired turbine conditions. The bench-scale system, test combustor, sorbent injection system, and the particulate collector system are described. The test program and economics are briefly discussed.

25269 (DOE/METC–89/6099, pp. 280-286) **A membrane-based process for flue-gas desulfurization.** Radovich, J.M. (Bend Research, Inc., OR (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

Bend Research, Inc., has developed a membrane-based technology that replaces packed towers or conventional scrubbing systems for the removal of SO_2 from the flue gas of coal-fired power plants. The technology uses a membrane contactor to contact the flue gas with the liquid absorbent that removes SO_2. A membrane contactor is a separation device in which two phases are separated by an SO_2-permeable polymeric membrane. In this application, the membrane is a microporous, hydrophobic material. The SO_2 passes through the gas-filled micropores into the flowing solution, where it is absorbed and removed by reacting with sodium sulfite. Any suitable solution can be used as the absorbent for SO_2 in the membrane contactor. For development work, the authors chose sodium sulfite–the solution that is used in the Dual-Alkali and Wellman-Lord flue-gas FGD processes. A field-test unit was constructed. It contains four membrane modules, each with 30 ft^2 of membrane area. This test unit can process up to 200 SCFM of flue gas at a maximum temperature of 170 F. In the field tests at Pacific Power and Light's power plant in Centralia, Washington, at least 85% of the SO_2 in the flue gas was removed.

25270 (DOE/METC–89/6099, pp. 287-292) **Gas separations using inorganic membranes.** Egan, B.Z. (Oak Ridge National Laboratory, TN (USA)); Fain, D.E.; Kidd, G.J.; Singh, S.P.N. US-DOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The overall R&D program consists of the development of membrane separation systems for the recovery of H_2 and the separation of acid gases (H_2S, CO_2) from synthesis gas. The program is a multiyear effort that is to be conducted in stages, with intermediate decision points to determine the course of future R&D efforts. There are two major parts to the program that are closely interlinked. Part A consists of the following elements: (1) identification of the candidate membrane materials based upon the chemistry of the separations environment; (2) evaluation of the separations capability of the fabricated membranes in terms of permeabilities and fluxes of gases; (3) assessment of the worldwide R&D activity in this field; and (4) reporting on the project. Part B comprises fabricating and physically characterizing the candidate membranes using the specialized techniques presently available only at the Oak Ridge Gaseous Diffusion Plant. Efforts will be made to transfer the technology to industry. Part A is funded by the Gas Stream Cleanup Program, and Part B is funded by the AR&TD Fossil Energy Materials Program. This is a new program, beginning in April 1988, so experimental results are not yet available.

25271 (DOE/METC–89/6099, pp. 294-303) **Integrated operation of a pressurized fixed-bed gasifier and hot gas desulfurization system.** Gal, E. (GE Environmental Systems, Lebanon, PA (USA)); Furman, A.H.; Ayala, R. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The overall objective of the project is to demonstrate successful operation of a novel, moving bed, hot fuel gas desulfurization system, integrated with the GE air-blown, fixed-bed, coal gasifier in Schenectady, New York. The demonstration will utilize the full flow from the one-ton-per-hour gasifier operating at 300 psig with an outlet temperature of 1050 - 1150 F. An advanced formulation of zinc ferrite, designed to preserve sulfur reactivity and regenerability while significantly improving mechanical durability, will be evaluated in large scale, hot, long term operation. When demonstrated, this gasifier/hot gas cleanup configuration will provide a key building block element for advanced integrated gasification, gas turbine power generation systems. Background, procedures, and accomplishments to date are described.

25272 (DOE/METC–89/6099, pp. 304-314) **Integration and testing of hot desulfurization and entrained glow gasification for power generation systems.** Robin, A.M. (Texaco, Inc., Montebello, CA (USA)); Wu, J.C.; Najjar, M.S. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The primary objective of this program is to demonstrate, on a pilot plant scale, an improved integrated coal gasification combined cycle (IGCC) electric power generation system utilizing hot gas cleanup and the commercially proven Texaco Coal Gasification Process. New specialized instrumentation, developed for coal gasification, also will be tested during this program. The preliminary desulfurization research during the first year of the program will consist of four tasks as follows: Theoretical Studies; Bench Scale Tests; PDU Scoping Tests; and Advanced Instrumentation Evaluation, all of which are described. The tests program for the first year includes a one-day shake-down run and three three-day scoping runs, all of with pure oxygen as the oxidant. Washed Pittsburgh No. 8 coal (2.1% S) will be used for most of the tests. However, tests of a higher sulfur bituminous coal are also planned. Several

on-line analytical instruments currently under development at METC have been selected for testing. During the first year, only the continuous alkali monitor will be available. This instrument will be set up to analyze the syngas at the top of the radiant syngas cooler. Accomplishments to date are described.

25273 (DOE/METC–89/6099, pp. 315-327) **Fluidized bed coal gasification with hot gas cleanup.** Haldipur, G.B. (KRW Energy Systems Inc., Madison, PA (USA)); Smith, K.J.; Datta, S.; Cherish, P. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The overall goal of the program is to provide an engineering design data base for an Integrated Gasification Combined Cycle (IGCC) technology, which is comprised of a pressurized fluid-bed gasifier with in-bed desulfurization, an external polishing desulfurizer using a regenerable metal oxide sorbent, and appropriate particulate cleanup trains for turbine protection and control of environmental emissions. Specific objectives of the technology development programs are to (1) characterize the operational performance of a 15 tpd pilot-scale gasifier with in-bed desulfurization, (2) demonstrate hot gas particulate cleanup using cyclones and barrier filters, and (3) develop pilot-scale operability data on fixed-bed external desulfurizer using a zinc ferrite sorbent. Results on the following are described: gasifier and in-bed desulfurizer; recycle cyclones; non-recycle high-efficiency cyclones; ceramic candle filter system; external desulfurizer; operation with dust-laden gas; operation with filtered gas; and fuel gas conditioning effects.

25274 (DOE/METC–89/6099, pp. 328-339) **Environmental control systems in coal-fueled gas turbines: Technical progress report.** LeCren, R.T. (Solar Turbines Incorporated, San Diego, CA (USA)); Hendrix, H.L.; Cowell, L.; Hasan, A. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objective of this task of the contract is to develop a reliable system of environmental control for coal-fueled gas turbine systems. The ability to operate a gas turbine in a direct coal-fueled mode for an economic lifetime is dependent on the efficiency of the particulate removal system. Also, a coal-fueled system must be prepared to meet ever-tightening environmental restrictions with regards to gaseous and particulate emissions. This task of the contract deals with the removal of particulate via an impact separator and barrier filters and the removal of sulfur oxide emissions by use of suitable sorbents injected into the gas stream. Results to date from PRIS (Particulate Rejection Impact Separator), sorbent injection studies, and secondary zone cleanup with ceramic filters are discussed.

25275 (DOE/METC–89/6099, pp. 340-354) **Gas cleanup systems analysis.** Craig, K.R.; Koch, R.W. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

Removal of contaminants and pollutant precursors from high-temperature, high-pressure (HTHP) coal-derived gas streams is critical to the realization of the full potential of emerging coal technologies. The objective of the gas cleanup systems analysis effort at the Morgantown Energy Technology Center (METC) is to identify, evaluate, and quantify the technical and economic benefits of evolving HTHP cleanup and other separation technologies. Previous systems and cost analyses have shown that commercially available technologies (gasifiers and gas turbines) can provide significant efficiency improvements and cost of electricity (COE) reductions for integrated gasification combined-cycle (IGCC) power production systems. Revised analyses based on emerging technologies show that HTHP contaminant removal processes have the potential to improve previously noted system cost and performance benefits. Developing technologies hold promise for even further process simplification (combining several contaminant removal steps in one unit) and efficiency gains. Quantified evaluations of these benefits are presented. Also presented are preliminary results from the investigation of advanced separation technologies as applied to nonpower generation systems.

25276 (DOE/METC–89/6099, pp. 355-369) **Design basis for zinc ferrite hot gas desulfurization systems.** Kasper, S. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

Morgantown Energy Technology Center (METC) and its contractors have been conducting a series of tests with zinc ferrite to determine its ability to remove hydrogen sulfide from coal-derived gases at elevated temperatures. Many properties such as capacity, reactivity, durability, and others have been measured over an extended period and through numerous cycles of operation. The ultimate objective is to establish the data needed for the design of a reliable and economical commercial-scale hot gas cleanup system. At this stage of development, enough data exist to permit the design of a fixed-bed zinc ferrite desulfurization system with predictable performance characteristics. Recommended values for design are: Space Velocity - 2000/Hour; Superficial Velocity - 2 Feet/Second Maximum; Sulfidation Temperature - 1200 F Maximum; Regenerant Gas - Steam/Air for Oxidation Phase; Regeneration Bed Temperature - 1450 F Maximum; Sulfate Formation - 3%; Sorbent Capacity - Initial, 32%; Long Term (> 40 Cycles), 10%; Sorbent Attrition - .0022 Weight Fraction/Cycle, or .22%/Cycle. A preferred configuration includes in-bed desulfurization in the gasifier and recycle of spent regeneration gas to the gasifier. Ninety percent sulfur removal is selected as being achievable in fluidized-bed gasifiers. Clean product gas is used as reductive regenerant and is recycled to the gasifier. The basis of design presented is suitable for conceptual design of commercial-scale facilities or a guide for detailed process design of test-scale facilities.

25277 (DOE/METC–89/6100, pp. 9-17) **Gas-gas separations for coal gasification: A critical overview.** Keller, G.E. II (Union Carbide Corporation, South Charleston, WV (USA)). USDOE Morgantown Energy Technology Center, WV (USA). 8 Dec 1988. (CONF-881227–: Separation technology workshop for coal gasification, Morgantown, WV (USA), 8 Dec 1988). In *Proceedings of the separations technology workshop for coal gasification.* Order Number DE89000905. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Gas-gas separations are ubiquitous in coal-gasification processes. These separations include the removal of both trace and bulk constituents of the gas exiting the gasifier as well as the separation of air if oxygen is used in the gasifier. These separations and the processes which pertain to them are the subject of this paper. First some overall economics for coal gasification are discussed. This allows us to put these separations into their proper context. Then the paper looks critically at the present-day processes used for these separations, and following that speculates on some useful technology directions. Finally the role and use of economics and basic chemical engineering in carrying out further process research are discussed.

25278 (DOE/METC–89/6100, pp. 18-23) **Gas separation in the Tennessee Eastman coal gasification complex.** Shisler, J.L. (Tennessee Eastman Company, Kingsport (USA)). USDOE Morgantown Energy Technology Center, WV (USA). 8 Dec 1988. (CONF-881227–: Separation technology workshop for coal gasification, Morgantown, WV (USA), 8 Dec 1988). In *Proceedings of the separations technology workshop for coal gasification.* Order Number DE89000905. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The coal gasification facility at Tennessee Eastman Company (TEC) is designed to produce approximately 500 million pounds per year of acetic anhydride. Methanol, methyl acetate, and acetic acid are also produced within the complex. The gasification plant utilizes two Texaco entrained-bed quench gasifiers. Each gasifier can supply 100 percent of the gas required for the downstream chemical production areas. During the engineering and design phase of the project, two processes were considered for acid gas removal, Rectisol and Selexol. The primary reason that Rectisol was chosen was based on information that Rectisol would be more

efficient in its ability to remove carbonyl sulfide from synthesis gas. A few alterations have been made in the Rectisol plant to improve its operation: (1) Selective absorption of H_2S and CO_2; (2) Hydrogen Sulfide/Ammonia Stripping; (3) Corrosion; and (4) Insoluble Solid Deposits. These are briefly discussed. Only two additional improvements are currently being studied in the Rectisol process: ammonia removal from the circulating methanol, and odor control during start-up and process upset conditions. Additional areas where research would be beneficial are discussed. The overall performance of the plant is very satisfactory.

25279 (DOE/METC–89/6100, pp. 24-34) **Discussion - gas-gas separations.** USDOE Morgantown Energy Technology Center, WV (USA). 8 Dec 1988. (CONF-881227–: Separation technology workshop for coal gasification, Morgantown, WV (USA), 8 Dec 1988). In *Proceedings of the separations technology workshop for coal gasification.* Order Number DE89000905. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

A series of questions was provided to the leaders to help guide the discussions. It was not required that any or all of the questions be discussed, and issues other than those raised by the questions were discussed by some of the groups. This summary of the results of the discussions is organized around the questions; additional topics and comments are included at the end. The questions receiving the most comments were: (1) Is recovery and/or recycling of CO_2 practical in gasification processes? (2) Will membranes be developed to commercialization for use in gasification systems? Consider both inorganic (ceramic, metal) and organic (low temperature) membranes. (3) What are the needs/opportunities for advancement in pressure-swing-adsorption and cryogenic gas separation technologies? Already commercial, how can they be made cheaper and applicable to smaller flow rates. (4) What are the major problems caused by trace contaminants in gas separation processes?

25280 (DOE/METC–89/6100, pp. 37-60) **Novel separation processes for solid/liquid separations in coal derived liquids.** Henry, J.D. (Arizona State Univ., Tempe (USA)); Prudich, M.E.; Vaidyanathan, K.R. USDOE Morgantown Energy Technology Center, WV (USA). 8 Dec 1988. (CONF-881227–: Separation technology workshop for coal gasification, Morgantown, WV (USA), 8 Dec 1988). In *Proceedings of the separations technology workshop for coal gasification.* Order Number DE89000905. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The removal of the mineral matter found in coal derived liquids is a very difficult solid/liquid separation process. Clays, pyrites and other minerals that occur in coal ultimately find their way into the liquefied product. This is the case, e.g., for both the solvent refined coal (SRC-I) and H-Coal processes. The ash content of bituminous coals which may be fed to coal liquefaction processes normally ranges from 6 to 17 wt.%. The ash content of the coal liquid product can range from 4 to 20 wt.% depending upon the liquefaction process. The solid/liquid separation is complicated by a hydrocarbon coating associated with the mineral matter particles. In many cases, this coating is composed of an asphaltic material. A more detailed discussion of the characteristics of the minerals and this coating is presented in a later section. There are similarities between the behavior of mineral matter particles in coal derived liquids and other synthetic liquid fuels such as tar sand produced oils and shale oil retort liquids. The discussion here is limited to particle removal from coal derived liquids. The primary objective of this review paper is to present and discuss current results relating to novel solid/liquid separation processes that would be reasonable alternatives to the more conventional processes such as filtration. The discussion will center on two classes of techniques which rely on the precipitation of asphaltic materials from the oil phase which in turn promote the agglomeration of the mineral matter in coal derived liquids and processes which exploit the surface characteristics of the mineral matter, or the mineral matter with its asphaltic coating, by use of either a liquid phase or a gas phase as a separating agent.

25281 (DOE/METC–89/6100, pp. 73-78) **Discussion - liquid-particle separations.** . USDOE Morgantown Energy Technology Center, WV (USA). 8 Dec 1988. (CONF-881227–: Separation technology workshop for coal gasification, Morgantown, WV (USA), 8 Dec 1988). In *Proceedings of the separations technology workshop for coal gasification.* Order Number DE89000905. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

From a practical viewpoint, a major problem with liquids produced from both coal and oil shale is the handling/removal of particle contained in these products. This workshop session addressed several aspects of this issue. The major questions addressed in these discussions were (1) What are the major problems and information gaps associated with coal liquids with respect to liquid-particle separations? (2) What are the limitations regarding the application of conventional liquid-particle methods to coal liquids? and (3) What novel methods could potentially be applied to the separation of particles from coal liquids?

25282 (DOE/METC–89/6100, pp. 81-102) **Coal based liquid fuel separated from a mild gasification coal liquid without hydrotreating.** Miin, T.C.T. (UCC Research Corporation, Bristol, VA (USA)). USDOE Morgantown Energy Technology Center, WV (USA). 8 Dec 1988. (CONF-881227–: Separation technology workshop for coal gasification, Morgantown, WV (USA), 8 Dec 1988). In *Proceedings of the separations technology workshop for coal gasification.* Order Number DE89000905. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

A mild coal gasification liquid was beneficiated to yield a coal-based liquid diesel fuel. This fuel has similar characteristics to conventional petroleum diesel in all aspects. Stationary engine tests also showed comparable performance. Durability engine tests are still needed to accumulate confidence for marketing this fuel. Thus, the coal liquid was distilled, washed by alkaline, acid, and neutral water; or extracted by light oils; or precipitated to yield the coal-derived liquid diesel fuel. No hydrotreating procedures were used in this development. Economic evaluation of this fuel (not shown in this paper) shows that the successful continuous mild coal gasification process, which is being developed by United Coal Company Research Corporation (UCCRC), will provide low enough cost feedstock for processing this fuel. That will make the production of this fuel economic even under the current low oil price situation.

25283 (DOE/METC–89/6100, pp. 103-105) **Discussion - liquid-liquid separations.** USDOE Morgantown Energy Technology Center, WV (USA). 8 Dec 1988. (CONF-881227–: Separation technology workshop for coal gasification, Morgantown, WV (USA), 8 Dec 1988). In *Proceedings of the separations technology workshop for coal gasification.* Order Number DE89000905. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Upgrading processes under liquid-liquid separations were classified in two categories: processes to remove contaminants, and processes for separating desired products. The workshop discussions addressed the following issues: (1) What are the desired products from coal-derived liquids? (2) What are the existing upgrading processes? (3) What additional research needs to be done? and (4) What are the potential problems associated with upgrading coal-derived liquids?

25284 (DOE/METC–89/6100, pp. 109-124) **Fundamentals of gas-particle separation processes at high temperature and pressure.** Leith, D. (Univ. of North Carolina, Chapel Hill (USA)). USDOE Morgantown Energy Technology Center, WV (USA). 8 Dec 1988. (CONF-881227–: Separation technology workshop for coal gasification, Morgantown, WV (USA), 8 Dec 1988). In *Proceedings of the separations technology workshop for coal gasification.* Order Number DE89000905. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This paper reviews fundamental mechanisms by which particles can be separated from a gas stream at the conditions under which a coal gasifier must operate. Temperature and pressure-dependent terms that affect particle collection include gas density, gas viscosity, and the mean free path of gas molecules. The particle-collection mechanisms considered here include inertial forces, media and cake filtration (including impaction, diffusion, interception), electrostatic precipitation, and agglomeration. Current technology for gas-solids separations at high temperature and pressure often involves use of one or more stages of cyclones in series to remove larger particles, followed by a secondary or tertiary collector that provides final cleanup at high efficiency.

Candidate cleanup devices for high temperature/high pressure applications to follow the cyclones include electrostatic precipitators, granular bed, nested fiber, ceramic cross-flow, and ceramic bag filters. Important questions remain concerning the ability of these secondary or tertiary devices to operate effectively and reliably under extreme conditions of temperature and pressure found in some coal gasification processes. Many of these concerns relate to the ability of their materials of construction to withstand long term use, particularly the rigors of repeated cleaning. In addition, research is underway to improve the collection efficiency of the cyclone precleaners. Although the chief concern with cyclones is that their efficiency is low for particles smaller than five or ten micrometers in diameter, recent research suggests that cyclones can be built that will have a cut diameter around one micrometer.

25285 (DOE/METC–89/6100, pp. 125-143) **Hot gas cleanup process demonstration of ceramic filters for IGCC [Integrated Gasification Combined Cycle] power generation.** Cherish, P. (M.W. Kellogg Co., Houston, TX (USA)); Holmgren, J.D. USDOE Morgantown Energy Technology Center, WV (USA). 8 Dec 1988. (CONF-881227–: Separation technology workshop for coal gasification, Morgantown, WV (USA), 8 Dec 1988). In *Proceedings of the separations technology workshop for coal gasification.* Order Number DE89000905. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

KRW Energy Systems Inc. of The M. W. Kellogg Company has been engaged in a coal gasification and hot gas cleanup technology development program at its pilot plant located at the Waltz Mill Site near Pittsburgh, PA. One of the major applications of Kellogg's KRW technology is electric power generation by means of Integrated Gasification Combined Cycle (IGCC). KRW IGCC technology is of particular interest to electric utilities because it is expected to result in nominal 300-400 MW power plants with a net heat rate of about 8300 Btu/kWh when based on a present day gas turbine, and about 7800 Btu/kWh with advanced gas turbine units. Capital costs are expected to be quite competitive with other technologies. The technology is capable of using any rank of coal and will be demonstrated beginning in late 1992 at the Appalachian Project, a nominal 60 MW IGCC power plant which is part of the Department of Energy's Clean Coal Program. The project is sponsored by The M. W. Kellogg Company and Bechtel Development Company. The process demonstration test results of a ceramic candle filter design for hot gas cleanup is described, specific objectives stated and the performance summarized.

25286 (DOE/METC–89/6100, pp. 144-155) **Discussion - gas-particle separations.** USDOE Morgantown Energy Technology Center, WV (USA). 8 Dec 1988. (CONF-881227–: Separation technology workshop for coal gasification, Morgantown, WV (USA), 8 Dec 1988). In *Proceedings of the separations technology workshop for coal gasification.* Order Number DE89000905. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Gas-particle separation is regarded by some as the Achilles Heel of advanced, coal-based, energy and chemical systems. The area is large and the problems many faceted. However, the gas-particle session discussion can be organized into three large areas: materials, operating/testing, and separation techniques. What follows is a summary of the discussion in these three areas. As such, it reflects only the views/comments of the participants. Suggested topics for discussion were provided in all three areas to assist the participants.

25287 (EPRI-GS–6219, pp. 10.3-10.15) **Chemical and physical changes during coal processing.** Derbyshire, F. (Sutcliffe Speakman Carbons Ltd., Lancashire (England)); Davis, A. Electric Power Research Inst., Palo Alto, CA (USA). Jan 1989. (CONF-8805259–: 13. annual EPRI conference on fuel science and conversion, Santa Clara, CA (USA), 18-19 May 1988). In *Thirteenth annual EPRI conference on fuel science and conversion.* Order Number DE89006673. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Certain aspects of the chemical and physical changes which occur during coal processing are discussed in relation to the influences of coal oxidation and catalytic hydrogenation under low-severity conditions. The adverse effects of oxidation on thermoplastic properties and on the conversion of coals to liquids is related to the formation of crosslinks in the coal structure. This involves the thermally-induced reactions of oxygen-containing functional groups. Conversely low-temperature catalytic hydrogenation suppresses this tendency and can promote the cleavage of existing crosslinkages. The breakdown of the coal may be accompanied by enhanced fluidity. Moreover, the structural modifications produced by low-temperature reaction can have a profound effect upon coal behavior in subsequent reactions at higher temperatures. Microscopic techniques and in particular fluorescence microscopy can be usefully applied to the study of the structural changes produced by hydrogenation.

25288 (EPRI-GS–6219, pp. 11.3-11.19) **Recent LPMEOH (liquid phase methanol) process research and field modifications for the Laporte program.** Weimer, R.F. (Air Products and Chemicals, Inc., Allentown, PA (USA)); Studer, D.W.; Holley, E.P.; Hsiung, T.H. Electric Power Research Inst., Palo Alto, CA (USA). Jan 1989. DOE Contract AC22-85PC80007. (CONF-8805259–: 13. annual EPRI conference on fuel science and conversion, Santa Clara, CA (USA), 18-19 May 1988). In *Thirteenth annual EPRI conference on fuel science and conversion.* Order Number DE89006673. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

In April 1987, the concluding phase of research and Process Development Unit testing was begun to develop data supporting the design and future operation of a larger scale LPMEOH process demonstration plant. This work includes implementation and PDU testing of process improvements identified during previous work, demonstration of long-term catalyst activity maintenance, and process and design engineering work generic to a scaled-up facility. A parallel research program is being conducted to enhance the technical data base for the LPMEOH Process. Of the eight research subtasks, 2 (identifying an alternate liquid media; identifying alternate catalysts) have been completed and three (in-situ reduction optimization and slurry storage; catalyst poison studies; life test on alternate slurry system) are more than 50% complete. The modifications to the LaPorte PDU have been designed, and most major new equipment has been procured. Field construction is underway.

25289 (EPRI-GS–6219, pp. 14.3-14.19) **Effects of coal cleaning on direct liquefaction.** Gollakota, S.V. (UE and C, Wilsonville, AL (USA)); Hollenack, W.R.; Lee, J.M. Electric Power Research Inst., Palo Alto, CA (USA). Jan 1989. DOE Contract AC22-82PC50041. (CONF-8805259–: 13. annual EPRI conference on fuel science and conversion, Santa Clara, CA (USA), 18-19 May 1988). In *Thirteenth annual EPRI conference on fuel science and conversion.* Order Number DE89006673. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

An analysis of the effects of feed coal ash content on coal conversion and energy rejection was made based on the most recent data obtained in CC-ITSL (catalytic-catalytic close-coupled integrated two stage Liquefaction) mode using bituminous coals and Shell 317 bimodal catalyst. The data points obtained with Illinois No. 6 coal and Ohio No. 6 coal indicated relationships between the feed coal ash content and coal conversion as well as energy rejection. Very high coal conversions (ca. 97 wt% MAF coal) and very low energy rejections (ca. 7%) were observed with cleaned Ohio coal. An increase in coal conversion with a decrease in feed coal ash content was thought to be due to increased rejection of less reactive coal during cleaning. The decrease in energy rejection with a decrease in feed coal ash content was attributed to a decrease in organics loss to ash concentrate. The results indicate that significant benefits with respect to process efficiency, operability, and economics may be realized by cleaning coal prior to liquefaction.

25290 (EPRI-GS–6219, pp. 15.3-15.33) **Recent developments in coal liquefaction at Wilsonville.** Lee, J.M. (UE and C, Wilsonville, AL (USA)); Davies, O.L.; Pinkston, T.E., Gough, J.R. Electric Power Research Inst., Palo Alto, CA (USA). Jan 1989. DOE Contract AC22-82PC50041. (CONF-8805259–: 13. annual EPRI conference on fuel science and conversion, Santa Clara, CA (USA), 18-19 May 1988). In *Thirteenth annual EPRI conference on fuel science and conversion.* Order Number DE89006673. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Two close-coupled integrated runs were completed during the past year at the Advanced Coal Liquefaction R and D Facility at Wilsonville, Alabama processing high ash Illinois No. 6 and low ash Ohio No. 6 bituminous coals in the catalytic-catalytic mode of operation. Shell 317 catalyst (bimodal NiMo) was used for both reactors and catalyst performance is compared with Amocat 1A and 1C catalysts used for previous runs in terms of distillate yields, catalyst deactivation and replacement rates. The effects of low ash feed coal, high resid recycle, high second stage reaction temperature and high system space velocity on process performance are discussed. The impact of elimination of the interstage separator on cost reduction is discussed. Catalyst replacement rates for the all-distillate product slate are projected as a function of the second stage reaction temperature and system space velocity. Finally, aspects of optimum and cascading catalyst requirements are presented.

25291 (EPRI-GS–6219, pp. 16.3-16.17) **HRI coal/oil co-processing technology research, demonstration and commercialization.** Duddy, J.E. (Hydrocarbon Research, Inc., Lawrenceville, NJ (USA)); MacArthur, J.B.; Smith, T.O. Electric Power Research Inst., Palo Alto, CA (USA). Jan 1989. (CONF-8805259–: 13. annual EPRI conference on fuel science and conversion, Santa Clara, CA (USA), 18-19 May 1988). In *Thirteenth annual EPRI conference on fuel science and conversion.* Order Number DE89006673. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Advancements made in the development of the HRI Coal/Oil Co-Processing Technology have been impressive with the completion of the Coal/Oil Co-Processing Program at the end of 1987. Bench-scale research in this program has established an initial data base and research efforts are continuing with the added support of the US Department of Energy (DOE) and other industrial participants, to better understand feedstock interaction and to identify process improvements. In addition to this continued research activity, work has been started on the preliminary engineering design of a prototype commercial coal/oil co-processing plant. A 2 ton per day Process Development Unit demonstration run will be performed at HRI in 1988 in support of this project. Prototype commercial plant demonstration operations could start as early as 1992. This paper presents an overview of these programs as well as recent bench-scale results, economics and further data to support the concept of process synergy in coal/oil co-processing.

25292 (EPRI-GS–6219, pp. 3.3-3.16) **Microbial conversion of coal and coal waste materials: Product characterization, electron microscopy, and the low molecular weight factor.** Wilson, B.W. (Pacific Northwest Labs., Richland, WA (USA)); Fredrickson, J.; Stewart, D.L.; Thomas, B.L.; Campbell, J.A.; Bean, R.M. Electric Power Research Inst., Palo Alto, CA (USA). Jan 1989. (CONF-8805259–: 13. annual EPRI conference on fuel science and conversion, Santa Clara, CA (USA), 18-19 May 1988). In *Thirteenth annual EPRI conference on fuel science and conversion.* Order Number DE89006673. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Microbial conversion of coal and coal-derived products is a potentially important technology for production of clean fuels, as well as for remediation of coal tar contaminated waste sites. During the last year, substantial progress has been made toward understanding biosolubilization phenomena. Its applicability has been extended to higher rank coals, as well as to model compounds representative of coal tar waste materials. Methods have been developed for biosolubilization of Illinois #6 coal. Electron microscopic studies, which afforded important insights into the mechanisms of fungal biosolubilization, have been conducted on partially degraded coals. A non-enzymatic, low molecular weight factor that has potent solubilization activity has been isolated from C. versicolor, and characterized. Finally, continued studies on model compounds have shown that fungal enzymes and other factors responsible for coal biosolubilization are capable of attacking non-substituted polycyclic aromatic compounds, as well as substituted and heterocyclic aromatics. Phenotypical behavior of this kind is potentially important in the use of these organisms in coal and petrochemical waste remediation. This report deals with progress in these 4 areas.

25293 (PB–90-141318/XAB) **Cool Water Coal Gasification Program: Environmental Monitoring Plan, (4th) Quarterly report, October 1 through December 31, 1988.** Cool Water Coal Gasification Program, Daggett, CA (USA). 31 May 1989. 190p. Available from NTIS, PC A09/MF A01.

Also pub. as Radian Corp., Austin, TX. rept. No. DCN-89-218-049-103. See also PB–89-160907.

The Energy Security Act of 1980 established a program to provide financial assistance to private industry in the construction and operation of commercial-scale synthetic fuels plants. The Cool Water Coal Gasification Program is one of the four projects awarded financial assistance. The Program agreed to comply with existing environmental monitoring regulations and to develop an Environmental Monitoring Plan incorporating supplemental monitoring in the areas of water, air, solid waste, worker health and safety and socioeconomic impacts during the period 1984-1989. As the first commercial-scale integrated gasification combined-cycle plant for generating energy from coal, the plant is designed to process a variety of coals with no liquid discharge, produce non-hazardous solid wastes, and produce very few air emissions. Monitoring data are to provide an information base for evaluating plant operations and for establishing information on environmental uncertainties associated with replication of synthetic fuels facilities.

25294 (PB–90-142233/XAB) **Economic benefits of the coal-gasification program at GRI (Gas Research Institute). Annual report, September 1982-June 1983.** Haas, S.M.; Marshalla, R.A.; Nesbitt, D.M.; Oman, D.B. Decision Focus, Inc., Los Altos, CA (USA). 1983. 56p. Available from NTIS, PC A04/MF A01.

See also report No. 1 PB–90-142225.

Analysis shows that the value through 2025 at a five percent real discount rate of the overall economic benefit that would result from the technical success of coal gasification under GRI funding compared to failure is 33 billion dollars. The portion of that expected benefit specifically attributable to GRI funding is computed to be 6 billion dollars. The analysis concludes that despite the different time frames toward which coal gasification and other key supply programs are directed, their benefits are highly linked.

25295 (PB–90-148974/XAB) **Cool Water Coal Gasification Program: Monitoring Review Committee meeting report, Daggett, California, February 28, 1989.** Cool Water Coal Gasification Program, Daggett, CA (USA). 28 Feb 1989. 94p. Available from NTIS, PC A05/MF A01.

See also PB–89-160915.

The Energy Security Act of 1980 established a program to provide financial assistance to private industry in the construction and operation of commercial-scale synthetic fuels plants. The Cool Water Coal Gasification Program is one of the four projects awarded financial assistance. This Program agreed to comply with existing environmental monitoring regulations and to develop an Environmental Monitoring Plan incorporating supplemental monitoring in the areas of water, air, solid waste, worker health and safety, and socioeconomic impacts during the period 1984-1989. As the first commercial-scale integrated gasification combined-cycle plant for generating energy from coal, the plant is designed to process a variety of coals with no liquid discharge, produce non-hazardous solid wastes, and produce very few air emissions. Monitoring data are to provide an information base for evaluating plant operations.

25296 (PB–90-162140/XAB) **Electron-transfer mechanisms in thermochemical gasification: A quantitative quantum-mechanical investigation. Final report, January 1986-December 1988.** Ratner, M.A. Northwestern Univ., Evanston, IL (USA). Dept. of Chemistry. Dec 1989. 29p. Available from NTIS, PC A03/MF A01.

See also PB–88-181292.

Coal gasification processes occur by preadsorption of the gasifier onto the coal, chemical reaction, and desorption of product. Several experimental investigations have suggested that electron transfer is an important process following the initial adsorption. The research has investigated the nature of electron transfer processes between aromatic species, using careful ab-initio wavefunctions for the electrons, a semi-continuum treatment of the solvent, Gauber states to represent the initial and final polarizations, and a polaron treatment of the nuclear dynamics. Important results concerning

the importance of energy equalization on donor and acceptor sites, the role of bridge assistance and the effect of inner shell dynamics on electron transfer have been published. In particular, the dominance of the so-called, coincidence event geometry, at which the local energies at donor and acceptor sites are identical, has been clearly demonstrated, as have important geometric variations in the superexchange-type coupling of donor and acceptor.

25297 **Chemical percolation model for devolatilization. 2. Temperature and heating rate effects on product yields.** Fletcher, T.H. (Sandia National Laboratories, Livermore, CA (USA). Combustion Research Facility); Kerstein, A.R.; Pugmire, R.J.; Grant, D.M. *Energy and Fuels (USA)*, 4(1): 54-60 (Jan-Feb 1990).

The chemical percolation devolatilization (CPD) model previously developed to describe the devolatilization behaviour of rapidly heated coal was based on the chemical structure of the parent coal. Percolation lattice statistics are employed to describe generation of finite tar clusters as labile bonds are cleaved in the infinite coal lattice. The model is used here to describe effects of heating rate and temperature on tar and gas release from coal. Coefficients for the net rate of competition between char formation and side-chain formation are generated from heated screen data performed at five different heating rates. The model also compares well with heated screen data obtained at 1000 K/s and different hold times at the final temperature as well as with data from entrained-flow reactors obtained at higher heating rates (10^4K/s) where particle temperatures have been measured. Results indicate that the CPD model predictions yield good agreement with published data for a wide range of coals and particle heating rates. 18 refs., 6 figs., 1 tab.

25298 **The effects of carbon dioxide and cation content on the rapid pyrolysis of a lignite.** Reuther, R.B. (USDOE Morgantown Energy Technology Center, Morgantown, WV (USA)); Jenkins, R.G. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA)*, 34(4): 1124-1136 (1989).

Lignite was pyrolysed at 900°C in an entrainment reactor and its weight loss was determined. The weight loss was increased by prior removal of cations from the lignite and by the use of CO_2 as entrainment gas in the presence or absence of cations. The mechanisms of these effects were discussed. 17 refs., 9 figs.

25299 **A chemical percolation model for devolatilization: temperature and heating rate effects.** Fletcher, T.H. (Sandia National Laboratories, Livermore, CA (USA). Combustion Research Facility); Kerstein, A.R.; Pugmire, R.J.; Grant, D.M. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA)*, 34(4): 1272-1279 (1989).

The coal pyrolysis model developed earlier was modified to account for the effect of heating rate on yield of volatiles. Coefficients were derived from experimental data for two high-volatile coals, and predictions of tar yield v. temperature were compared with published figures. 10 refs., 6 figs.

0105 Products and By-Products

Refer also to citation(s) 25736

0106 Properties and Composition

Refer also to citation(s) 25255, 25259, 25292, 25297, 25368, 26051

25300 (DOE/METC–88/6098, pp. 134-144) **Product and precursor properties of condensable hydrocarbons.** Hesbach, P.A.; Lamey, S.C. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The objectives of this study are: to correlate/predict physical/fuel properties and upgrading requirements to make specialized fuels such as high-energy density fuels; to develop rapid analytical protocols to analyze pyrolysis products for chemical composition; and to support evaluation activity. In order to predict potential fuel performance or estimate upgrading requirements, it is desirable to develop a relatively rapid and simple technique for determining the chemical properties of a fossil fuel and subsequently to be able to relate this chemical data to the required fuel properties. The initial steps in the development of this technique are reported in this paper. The development of an open-column separation scheme is described which will fractionate a given fossil fuel into appropriate fractions for analysis by suitable techniques, primarily nuclear magnetic resonance, but also by gas chromatography and gas chromatography/mass spectroscopy. Analysis of the data from both the chemical fractionation analyses and the characterization can then be used in appropriate equations to relate the chemical composition data to a number of fuel properties. Solvents used in this work, pentane and toluene, were HPLC-grade. Standard mild gasification model compounds, n-octane, cyclo-octane, diethylbenzene, decalin, tetralin, naphthalene, and phenanthrene were selected to represent the major chemical groups of most interest in assessing high-density fuels. Results on the standard mixture and Kerosene are presented.

25301 (DOE/PC/88924–6) **Thermodynamics of the solvent swelling of coal: Technical progress report No. 6, December 1, 1989–February 28, 1990.** Green, T.K. (Western Kentucky Univ., Bowling Green, KY (USA). Center for Coal Science). Western Kentucky Univ., Bowling Green, KY (USA). Ogden Coll. of Science, Technology and Health. 1990. 26p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88924. Order Number DE90009391. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sorption of pyridine by the pyridine-extract of an Argonne premium Illinois No. 6 coal was studied at several relative vapor pressures at 50°C and 70°C. The amount of pyridine sorbed by the extract increases linearly with pyridine pressure at each temperature. The extrapolated lines do not go through the origin. The intercept is tentatively interpreted as the total amount of pyridine that fills microvoids. Dissolution of pyridine into the extract thus increases linearly with pressure. More pyridine is sorbed at 50°C than at 70°C, consistent with an exothermic sorption process. Sorption of pyridine by the O-methylated extract also increases linearly with pressure, yielding nearly the same intercept as the original extract. However, the O-methylated extract sorbs considerable less pyridine than the extract at equivalent relative pressures. This result is expected since the O-methylated extract cannot hydrogen bond to pyridine. Like the extract, the O-methylated extract sorbs more pyridine at the lower temperature, consistent with an exothermic process. 3 refs., 10 figs.

25302 (ERP/ERL–89-40(TR)) **Utilization of pipelineable coal-water slurries for combustion.** Whaley, H.; Thambimuthu, K.V.; Wong, J.K. Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Energy Research Labs. May 1989. 8p. Available from Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Energy Research Labs.

The use of liquids to transport coal through pipelines, and the application of these fuels to combustion systems, is examined. Properties which lead to good combustion performance and give a good transportable slurry are identified. While high rank coals perform well as transportation coal-water slurries, they are not good from a combustion viewpoint, being difficult to ignite/burn. Lower rank coals, while they make good combustible coal-water fuels, are not successful as transportation fuels because of their lower thermal loading and the fact that additives are required to produce needed rheological properties. 3 refs., 6 figs.

25303 (ORNL/TM–11387) **Development and demonstration of techniques for the characterization of reference coal structures.** Allard, L.F.; Fuller, E.L. Jr.; Nolan, T.A.; Harris, L.A.; Tennery, V.J.; Coffey, D.W. Oak Ridge National Lab., TN (USA). Feb 1990. 47p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. Order Number DE90010209. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Research results on characterizing both the interfaces between coal and associated minerals and the atomic bonding characteristics in coal as a function of coalification are reported. This report includes results from experimental techniques which were explored for providing direct structural and chemical characterization of a number of coals from the Argonne National Laboratory premium coal sample suite. These coals include a range of coal types

(ranks) which are of major interest for producing electric power. Scanning electron microscopy, transmission electron microscopy, electron spectroscopy for chemical analysis, and infrared spectroscopy were applied to a number of coal samples. 13 refs., 34 figs., 3 tabs.

25304 Influence of weathering and low-temperature oxidation on the thermoplastic properties of coal. Khan, M.R. (USDOE Morgantown Energy Technology Center, Morgantown, WV (USA)); Jenkins, R.G. pp. 240 of Chemistry of coal weathering. Nelson, C.R. (ed.). Elsevier Science Publishers B.V., Amsterdam (Netherlands) (1989).

The thermoplastic properties of coal and the methods of measuring them are described. Factors affecting thermoplasticity are considered. The influence of low temperature oxidation on the thermoplastic properties is discussed. 71 refs., 11 figs., 2 tabs.

0108 Waste Management

Refer also to citation(s) 25255, 25264, 25292, 25736, 25737, 26596

25305 (ANL/CNSV-TM–186, pp. 11-20) **Description of a North Sea CO_2 enhanced oil recovery project.** Park, R.S. (Oil and Petrochemicals Consultant, Portsmouth (England)). Argonne National Lab., IL (USA). Jun 1988. (CONF-8703302–: Workshop on recovery and use of waste CO_2 in enhanced oil recovery, Denver, CO (USA), 19-20 Mar 1987). In *Recovery and use of waste CO_2 in enhanced oil recovery. Proceedings.* Order Number DE89002803. Available from NTIS, PC A06/MF A01.

Carbon-dioxide for enhanced oil recovery from UK offshore fields will be needed in the early 1990's and onwards. It is proposed to meet the initial demands by converting a Scottish coal fired power station to burn with oxygen instead of with air. The flue gas will be cooled, dried, compressed and fractionated to give high purity carbon dioxide. The co-produced nitrogen from the air separation plant which provides the oxygen may be used for EOR operations on other offshore fields. The recent UK commitment to retrofit some coal fired power stations with flue gas clean up systems will mean the project can claim environmental performance credits.

25306 (DOE/METC–89/6099, pp. 167-176) **Super-equilibrium sulfur removal from high temperature gases.** Chatwani, A.U. (Avco Research Laboratory, Inc., Everett, MA (USA)); Stickler, D.B. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objective of this program is to investigate the potential of chemical sorbents for sulfur removal from high temperature gases (1600-2400 K) under transient thermal nonequilibrium conditions. The scope of this work is to determine, from single pulse experiments, the effects of various sorbent properties and coal combustion conditions on sulfur capture. A single pulse batch reactor is used to simulate the conditions of sorbent particle injection into hot sulfur containing gases. A transient jet stirred reactor flow is used to disperse solid sorbent particles in a selected background combustible gas containing a known amount of hydrogen sulfide. Heating is accomplished by ignition of the combustible gas mixture. As it is postulated that the particle temperature plays a very important role in determining the sulfur capture, a task was undertaken was to monitor the solids transient temperature. An optical multichannel analyzer is used to follow the particles temperature by measuring the spectral emission from the solids as they heat up in the background gas. The effects of adiabatic gas temperature, sorbent particle size, sorbent-to-sulfur ratio, and process stoichiometry on the transient sulfur capture are being studied. In addition to limestone, the following sorbents are being investigated: calcium oxide, pressure hydrated lime, and an inert solid. the test plan also includes modeling support to determine kinetic constants for sulfur capture reactions. Transient particle temperature measurement and sulfur capture results are discussed.

25307 (DOE/METC–89/6099, pp. 212-216) **NO_x-char reactions: Kinetics and transport aspects.** Calo, J.M. (Brown Univ., Providence, RI (USA)); Suuberg, E.M. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The study of NO_x-char reaction systems will be conducted in two phases. Phase I involves the characterization of the chars with respect to structure and composition. The interaction of NO and co-adsorbates will be examined in a TGA sytem. The desorbed gases from these experiments will be examined to determine the resultant product gas composition upon desorption. Finally, the char surfaces will be doped with co-adsorbates suspected of playing a role in the NO-char reaction mechanism in order to assess whether these species inhibit the reaction and/or whether NO reduction occurs on the same sites or other sets of sites than those occupied by the co-adsorbent gases. Diffuse reflectance infrared spectroscopy will be tried in order to ascertain the nature of adsorbed surface oxides from NO alone, and in the presence of co-adsorbates. Phase II involves kinetics studies of the NO-char reaction system, which initially will be carried out thermogravimetrically as an extension of the characterization process in the TGA system. This will include steady-state kinetics measurements to determine global reaction rate orders and activation energies for the chars used. However, model discrimination between mechanisms and the measurement of individual rate constants will be done subsequently using a transient kinetics apparatus that has been developed expressly for the study of gasification reactions. Since it is anticipated that diffusion may play an important role, the intraparticle transport characteristics of NO in the various chars used will be measured using a new transient method. Results to date are discussed.

25308 (DOE/PETC/TR–90/6) **Flue gas cleanup with hydroxyl radical reactions.** Lee, Y.J.; Pennline, H.W.; Markussen, J.M. USDOE Pittsburgh Energy Technology Center, PA (USA). Feb 1990. 25p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90007265. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Electric discharge processes have been intensively tested for application to flue gas cleanup. Among the several means of OH-radical generation grouped as electric discharge, E-Beam irradiation is the one that has been most thoroughly studied. Corona glow discharge, especially pulsed corona glow discharge, on the other hand, has attracted attention recently, and several active research projects are being conducted in the United States, Japan, West Germany, and Italy. Other promising approaches for generating OH radicals efficiently are based on thermal or catalytic decomposition of OH-radical precursors. If mixing problems can be overcome to achieve homogeneous distribution of OH radicals in the flue gas stream, these methods may be applicable to flue gas cleanup. Because of their high OH-radical generation rates and potentially low capital costs, the following three approaches are recommended to be tested for their potential capability to remove SO_2/NO_x: (1) H_2/O_2 combustion in a hydrogen torch, (2) thermal decomposition of H_2O_2, and (3) catalytic decomposition of H_2O. Ideally, the OH radicals will convert SO_2 and NO_x to sulfuric acid and nitric acid. These acids or acid precursors would easily be removed from the flue gas by conventional technology, such as spray drying and wet limestone scrubbing. 67 refs., 2 tabs.

25309 (ERP/CRL–87-47(CF)) **Mobile plant and water treatment testing at the Crows Nest Resources Ltd. Line Creek washery during 1983.** Picard, J.L.; Hashmi, K.A.; Potoczny, Z.M. Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab. Apr 1987. 72p. Available from Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab.

Field tests were conducted on a water treatment mobile plant at the Crows Nest Resources Ltd. Line Creek washery, Alberta. One of the principle objectives was to complete the mechanical shakedown of the plant, and to provide for the continuing development of appropriate experimental procedures. In addition, the clarification and thickening potential of one anionic reagent and of four cationic-anionic reagent combinations were tested. The results indicate improved results in thickener operations could be achieved with reagents other than those being used. Recommendations are made as to requirements for scale-up of the process. A number of R & D projects are suggested. 16 figs., 30 tabs., 6 apps.

25310 (Juel–2293) **Kinetics of adsorptive flue gas desulfurization using activated coke.** Kostka, N.; Achenbach, E. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Reaktorbauelemente; Technische Hochschule Aachen (Germany, F.R.). Jul 1989. 109p. (In German). Order Number DE90767258. Available from NTIS (US Sales Only), PC A06/MF A01.

Dissertation submitted by N. Kostka.

This study describes the experimental determination of the kinetics of the adsorption of SO_2, H_2O and O_2 from flue gases by activated coke. Single activated coke grains were subjected to a flow of synthetic flue gases and the change in mass caused by the adsorption was recorded by means of a thermo balance. The experiments showed that the total amount of the sulfur dioxide adsorbed is converted with oxygen and water vapor into sulfuric acid. The influence of the temperature and the concentrations of the flue gas components on the speed of the SO_2 conversion was determined and quantified in a kinetic model. The kinetic data obtained by the single grains were transferred to activated coke beds. (orig.).

25311 (PB–90-148214/XAB) **Safe mine waste disposal, Appalachian coal province (1984).** Maberry, J.O. Geological Survey, Alexandria, VA (USA). 1989. 20p. Available from NTIS, PC A03/MF A01.

Listed are maps developed under the Safe Mine-Waste Disposal program of the U.S. Geological Survey. Maps show recent or old landslides, rockfalls and other areas susceptible to sliding. Other features include strip mines classified as to type and degree of reclamation, gravel pits, quarries and other man-made features that affect slope stability in vicinity of coal-mining activities.

25312 (PB–90-154741/XAB) **Economic analysis of alternative regulations for coal-mine waste. Final report.** Mathtech, Inc., Princeton, NJ (USA). 18 Dec 1981. 31p. Available from NTIS, PC A03/MF A01.

The report was prepared by MATHTECH, Inc., for the Economic Analysis Branch of the Office of Surface Mining (OSM), U.S. Department of the Interior. The purpose of the report is to assess the economic impact of different levels of regulatory control over the disposal of coal mine waste. The report is intended to assist OSM in complying with Executive Order 12291 and with relevant provisions of the Regulatory Flexibility Act, 5 U.S.C. 601 et seq. It contains five sections and one appendix. Section 2 provides a brief description of the research methodology and a summary of the regulatory costs. Section 3 presents a description of the key cost items associated with the regulatory alternatives. Section 4 presents a comparison of the key provisions of each regulatory alternative. Section 5 provides a regional cost analysis of these alternatives.

25313 **Use of dry scrubbers for high-sulphur-content coal.** Farber, P.S. (Argonne National Lab., IL (USA)). *Luz y Fuerza (Spain)*, 44(498): 27-34 (Nov-Dec 1989). (In Spanish).

The dry washing process combines two traditional technologies: spray drying - in use for more than 40 years in the manufacture of products as diverse as detergent, pigment for paint and instant coffee - and particle collection, including electrostatic precipitators and hose filters. Both systems are capable of eliminating more than 99% of particles from effluent gases. 1 fig., 5 tabs.

0109 Environmental Aspects

Refer also to citation(s) 25293, 25295, 25384, 25392, 26575

25314 (ANL/CNSV-TM–186, pp. 1-10) **Environmental issues of coal combustion: Acid rain and the greenhouse effect.** Hakkarinen, C. (Electric Power Research Institute, Palo Alto, CA (USA)). Argonne National Lab., IL (USA). Jun 1988. (CONF-8703302–: Workshop on recovery and use of waste CO_2 in enhanced oil recovery, Denver, CO (USA), 19-20 Mar 1987). In *Recovery and use of waste CO_2 in enhanced oil recovery. Proceedings.* Order Number DE89002803. Available from NTIS, PC A06/MF A01.

Coal combustion produces air emissions of carbon dioxide, sulfur oxides and nitrogen oxides, as well as other trace gases and particulates and water vapor. These compounds are transported through the atmosphere by the winds and may undergo physical and chemical transformations before their removal by deposition (wet or dry). The first three compounds are acidic to some degree, and their incorporation into precipitation will increase the acidity (lower the pH) from the neutral point of pH 7, producing what is known popularly as acid rain. Acid rain has been implicated as a cause of a variety of ills to ecological systems, materials, and possibly human health. Sulfur and nitrogen oxides are believed to be the primary contributors to acid rain in most continental and industrialized areas of the world. Carbon dioxide, while a weak contributor to rain acidity, is of more concern for its role in moderating the temperature of the earth's atmosphere. Computer models have projected that the observed increases in CO_2 content of the atmosphere (as well as increases in other radiatively important gases), will lead to a global warming of 2 to 5 C over the next century. Such a temperature increase, commonly referred to as the greenhouse effect, could have serious societal implications. Accelerating melting of polar ice, raising of mean sea levels, and regional modifications of weather patterns are some of the effects that may be possible. This paper reviews the state of knowledge and uncertainties of the environmental effects of acid rain and the greenhouse effect, especially as they relate to the combustion of coal.

25315 (PB–90-132465/XAB) **Acid-rain clouds over the Midwest: Impacts on waters.** Glass, G.E. Environmental Protection Agency, Duluth, MN (USA). Environmental Research Lab. c 1989. 8p. (EPA–600/D-89/260). Available from NTIS, PC A02/MF A01.

Water is a valuable and renewable resource but also a vulnerable resource. The present seasonal and geographical patterns of emissions and reaction products from fuel (coal, oil and natural gas) combustion increase from west to east across the Midwest and produce a gradient of increasing acidity in precipitation, averaging from pH 4.3 in Michigan to pH 5.3 in Minnesota.

25316 (PB–90-146390/XAB) **Annotated bibliography of alternative sediment control methodologies for mined lands.** Mining and Reclamation Council of America, Washington, DC (USA). Mar 1985. 88p. Available from NTIS, PC A05/MF A01.

Sediment control technology is subdivided into 6 major groups: surface protection measures that include surface stabilizers (dry mulch used with or without mulch binders with hydraulic mulching); spoil or soil surface mechanics manipulation measure that include contour furrowing with land imprinting, pitting and ripping; measurements used in conjunction with diversions and conveyances: check dams with sediment traps and level spreaders.

25317 (PB–90-146531/XAB) **Handbook of alternative sediment-control methodologies for mined lands.** Mining and Reclamation Council of America, Washington, DC (USA). Mar 1985. 183p. Available from NTIS, PC A09/MF A01.

The Surface Mining Control and Reclamation Act of 1977 requires persons conducting surface coal mining operations to prevent to the extent possible using the best technology currently available, additional contributions of suspended solids to streamflow or runoff outside the permit area, and comply with water quality requirements set by State and Federal laws. The purpose of the handbook is to compile data on the alternative erosion and sediment control measures, to describe their applicability and summarize their basic design and implementation guidelines. All the data presented in the report are retrieved from existing literature or are known to be used in the field. The compiled data on the alternatives to sedimention ponds are to serve as a basis for identification of the most suitable erosion and sediment control technology for individual mining sites.

25318 (PB–90-147281/XAB) **Environmental impacts of retention, removal, or maintenance of sedimentation ponds. Final report.** Jordan/Avent and Associates, San Francisco, CA (USA). Apr 1982. 108p. Available from NTIS, PC A06/MF A01.

Portions of this document are not fully legible.

The report presents a summary of the environmental impacts associated with: (1) compliance; (2) regulations as currently written; and (3) alternative actions as a result of possible regulatory changes. Environmental impacts of retaining sedimentation ponds will vary substantially depending on geographical location and site-specific parameters. Nature and magnitude of sedimentation pond removal impacts is closely related to the type of pond and the manner in which it is removed.

25319 (PB–90-147349/XAB) **Design manual for sedimentation control through sedimentation ponds and other physical/chemical treatment. Final report.** Simons, Li and Associates, Inc., Denver, CO (USA). Nov 1982. 176p. Available from NTIS, PC A09/MF A01.

The report is a design manual to guide the design engineer and/or operator in the design and maintenance of sedimentation ponds for the control of sediment from surface mine operations. The design methodologies presented address the meeting of effluent quality criteria.

25320 (PB–90-147356/XAB) **Development of subsidence damage criteria. Final report.** Bhattacharya, S.; Singh, M.M. Engineers International, Inc., Westmont, IL (USA). Oct 1985. 229p. Available from NTIS, PC A11/MF A02.

In the process of coal mining it is certain that some degree of disturbance of the overlying strata and consequent subsidence of the surface will result. The problem of land subsidence has faced engineers and geologists for many years and, when widespread movements and damage to surface structures occurred, systematic investigations were undertaken. The term subsidence, as used in the report, implies the total phenomenon of surface effects associated with the mining of minerals, and not only vertical displacement of the surface as is sometimes inferred in the literature.

25321 (PB–90-148073/XAB) **Natural gas use for pollution control.** Gas Research Inst., Chicago, IL (USA). Nov 1989. 6p. (GRI–89/0291). Available from NTIS, PC A02/MF A01.

Concern for acid rain prompted proposals to reduce harmful emissions from utility boilers fired with fossil fuels. Successful research in areas such as gas reburning, gas cofiring and the combination of gas reburning with sorbent injection can significantly reduce emissions of SO_2 and NOx at a lower cost than alternative control technologies, and provide the utility the option to rely on the existing fuel of choice, locally available coal. Emissions data are provided in tables.

25322 (PB–90-148495/XAB) **Flood model for the Tug Fork Basin, Kentucky, Virginia, and West Virginia. Water Resource Investigation.** Doyle, W.H.; Curwick, P.B.; Flynn, K.M. Geological Survey, Reston, VA (USA). Water Resources Div. 1983. 97p. (USGS/WRI–83-4014). Available from NTIS, PC A05/MF A01.

Surface mining of coal in the United States increased from 406 million tons to almost 800 million tons from 1978 to 1979. In the coal-rich 1,560-square-mile Tug Fork basin located in Kentucky, Virginia, and West Virginia, there has been a 2,500 percent increase since 1950 in areas affected by surface-mining activities. The study used a rainfall-runoff model to determine if land-use changes associated with surface mining in the Tug Fork basin have affected basin streamflow characteristics. The model was calibrated and verified for two periods, one representing 1980 land-use and one representing 1950 land-use. Two 29-year synthetic daily streamflow time series representing the two land-use conditions were generated.

25323 (PB–90-148503/XAB) **Erosion and sediment-control measures for coal mines: Handbook. Final report.** Barfield, B.J.; Clar, M.L.; Das, P.; Ferrandino, J.J. Hittman Associates, Inc., Columbia, MD (USA). Jun 1981. 254p. Available from NTIS, PC A12/MF A02.

The primary purpose of the handbook is to provide mining industry personnel and federal and state agencies with a reference document which provides guidelines on the selection and use of erosion and sediment control measures for coal mines. The guidelines include information on the suitability and applicability as well as design, installation, maintenance, and cost data for each control measure presented in the handbook. In addition, data on the effectiveness and cost-effectiveness have been provided for those measures where data are available. The materials presented in the handbook are national in scope and are applicable to all coal-bearing regions of the continental United States.

25324 (PB–90-148594/XAB) **Prediction of ground movements due to underground mining in the eastern United States coal fields. Volume 1. Development of prediction methods. Final report.** Agioutantis, Z.; Goodman, G.; Jarosz, A.; Karmis, M.; Schilizzi, P. Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (USA). Dept. of Mining and Minerals Engineering. Dec 1987. 209p. Available from NTIS, PC A10/MF A02.

This book presents the basic concepts of prediction methods and monitoring programs, analysis refinement of prediction methods applications to the eastern U.S. coalfield. Subsidence control and socio-economics considerations are also included.

25325 (PB–90-148602/XAB) **Surface-mining water-diversion design manual, September 1982.** Anderson, S.A.; Fullerton, W.T.; Li, R.M.; Peterson, M.R.; Schall, J.D. Simons, Li and Associates, Inc., Fort Collins, CO (USA). 1989. 477p. Available from NTIS, PC A21/MF A03.

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The design manual provides basic information and procedures for hydrologic analysis and design for water channels and diversions including design examples. It is a comprehensive design manual for use by experienced engineers and hydrologists.

25326 (PB–90-148610/XAB) **Aquatic invertebrates in the Warrior Coal Basin of Alabama.** Hanley, R.W.; Harris, S.C.; Mettee, M.F.; O'Neil, P.E.; Tennessen, K.J. Alabama Geological Survey, University, AL (USA). 1987. 312p. (BULL–127). Available from NTIS, PC A14/MF A02.

Alabama has substantial quantities of high-grade coal with current reserves estimated at 23.4 billion tons. For the coal resources of Alabama to be developed in an environmentally sound manner will require increased knowledge of the aquatic ecosystems. This is necessary as aquatic systems ultimately receive the impact via surface runoff and groundwater infiltration from any perturbation in the terrestrial environment. Aquatic invertebrates are often utilized in conjunction with water quality parameters as indicators of the status of receiving waters in assessment studies. Since most aquatic invertebrates have very limited mobility and yearly life cycles, any dramatic change in their environment is reflected in their population levels. However, in general, aquatic invertebrates are often difficult to identify and, within Alabama, poorly known, both ecologically and faunistically. This lack of information necessitates that mine operators conduct expensive impact studies to meet state and federal environmental regulations.

25327 (PB–90-148628/XAB) **Development of techniques for evaluation of coal-waste leachate problems. Technical report (Final).** Michalovic, J.G.; Fisher, J.C. Arvin/Calspan Advanced Technology Center, Buffalo, NY (USA). 15 Jul 1983. 156p. Available from NTIS, PC A08/MF A01.

A study was conducted to develop techniques to assess coal-waste leachate problems. A review of current literature and a survey of governmental agencies was performed to determine the state-of-the-art and the amount of information available with respect to coal-refuse piles. It was found that the existing data were somewhat limited with respect to the quantity and quality of leachate produced from refuse piles. An in depth study of two coal refuse sites was performed that focused on leachate characteristics based on physical and chemical composition of the refuse piles. A laboratory leaching test was developed using coal refuse sampled at the sites that allowed an evaluation of the coal refuse from the quality of leachate generated.

25328 (PB–90-148727/XAB) **State-of-the-art and guidelines for surface-coal-mine overburden sampling and analysis. Phase 1 report: Survey of current methods and procedures. Final report.** Barth, R.C.; Cox, L.G.; Giardinelli, A.; Sutton, S.M.; Tisdel, L.C. Colorado School of Mines, Golden, CO (USA). Research Inst. Nov 1981. 269p. (J–00607-1). Available from NTIS, PC A12/MF A02.

The study provides information on current methods and procedures used in the premining assessment of surface coal mine overburden. Topics addressed include: overburden drilling and sampling, parameters used for predicting overburden suitability in reclamation and for evaluating potential water quality impact, laboratory methods for analyzing overburden, and procedures for greenhouse testing of overburden. Primary information sources for the study included applicable federal and state regulations and guidelines, and published literature. Supplemental information was obtained through a survey of state regulatory agencies, coal mining

companies, and researchers interested in the study topics. The study is the first phase of a two-part program under the contract.

25329 (PB–90-148891/XAB) **Low-altitude photointerpretation manual for surface-coal-mining operations. Final report.** Evans, B.M.; Kern, J.R.; Stingelin, R.W. Office of Surface Mining Reclamation and Enforcement, Washington, DC (USA). Nov 1983. 155p. (OSM–158). Available from NTIS, PC A08/MF A01.

Portions of this document are not fully legible. Color illustrations reproduced in black and white.

The manual provides surface coal mine regulatory, inspection, and management personnel with a self-instructional handbook that covers the application of basic photointerpretation techniques to the identification of mining features and the evaluation of surface coal mining situations. The manual stresses the use of vertical and oblique aerial photographs in evaluating surface coal mining practices and the effects of these practices on an area. The manual describes various techniques available for the proper acquisition and use of vertical and oblique aerial photographs. The manual includes only the most applicable methods of obtaining and using black-and-white panchromatic, natural color, and color infrared photographs for mapping, classifying, analyzing and monitoring all phases of surface mining activity.

25330 (PB–90-148925/XAB) **Alternatives and recommended procedures for establishing a soil laboratory approval program (topsoil, topsoil substitutes, and supplements).** Divney, T.K.; Klingebiel, A.A.; Tilmann, S.E. Soil and Land Use Technology, Inc., Columbia, MD (USA). 30 Aug 1980. 179p. Available from NTIS, PC A09/MF A01.

The report provides recommended procedures for establishing soil quality control and lab approval program. Uniform soil analyses, tests and methods can be implemented along with a consistent soil lab approval and quality control program nationwide. Procedures are applicable to all coal-producing states wishing to develop a laboratory certification program.

25331 (PB–90-148966/XAB) **Improvement of overburden analytical technology. Final report, October 1982-August 1985.** Sobek, A.A.; Bogner, J.E.; Sullivan, P.J.; Laurito, A.W. Engineers International, Inc., Westmont, IL (USA). May 1986. 270p. Available from NTIS, PC A12/MF A02.

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There are several controversies in the use of overburden analysis techniques for reclamation planning in the U.S. coal basins. The coal basins have been divided into seven reclamation subregions and three major regions for the purposes of the study. The eastern U.S. coal region is characterized by acid mine drainage problems, and pre-mine prediction of this problem using overburden analysis techniques is controversial. The measurement of sodicity, in particular the use of the Sodium Adsorption Ratio versus the Exchangeable Sodium Percentage methods, is controversial in the western U.S. These problems and controversies are discussed in the report. A major contribution of the study has been the development of overburden standards representing the wide-range of lithologies in the western, midwestern, and eastern coal basins. The western, nutrient, and east/midwestern standards were analyzed to determine the potential and limitations of various overburden analysis techniques. A modified technique of measuring the accelerated weathering of the standards was also evaluated.

25332 (PB–90-148982/XAB) **Surface-mine reclamation plant materials studies. Progress report.** Soil Conservation Service, Bismarck, ND (USA). 1989. 245p. Available from NTIS, PC A11/MF A02.

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The report lists 13 trees/shrub species which appeared adapted to non-sodic glacial till mine spoil where competition was controlled. The highest growth/survival rate was for most species on the clean cultivated level site. Growth rates generally poor/competition most severe on wave-like site. No significant benefit from leveling competition was not controlled. While performance improved on tops-level site over wave-like/check sites, differences between 3 treatments minor. Few deciduous species tolerate grass/weed competition. Conifers as a group performed as well/better where spoil ridges/vegetation afford desiccation protection.

25333 (PB–90-149014/XAB) **Design of sediment-control measures for small areas in surface coal mining. Draft report.** Cotton, G.K.; Li, R.M.; Mussetter, R.A.; Simons, D.B.; Summer, R. Simons, Li and Associates, Inc., Fort Collins, CO (USA). Apr 1982. 311p. Available from NTIS, PC A14/MF A02.

The manual provides design information for four groups of sediment control structures and treatments which are suitable for use on small areas in surface coal mining. A detailed design procedure is given for each group which will estimate the total amount of settleable solids from a small area with a sediment control structure or treatment for a specific design storm. A procedure is also given for estimating the mean annual sediment yield from a small area. Information on design, installation, maintenance and cost is given for each sediment control measure. Methods for determining the maximum allowable area for each sediment control measure and for design of combined sediment control systems are presented. The design procedures contain numerous nomographs, graphs, and worksheets to facilitate the use of the design procedure. The sediment control measures, design procedures, and materials in the manual are applicable to coal-bearing regions of the continental United States.

25334 (PB–90-149030/XAB) **Rocky Mountain 1: Underground coal gasification test, Hanna, Wyoming. Volume 1. Operations. Summary report.** United Engineers and Constructors, Inc., Denver, CO (USA). Stearns-Roger Div. Mar 1989. 298p. Available from NTIS, PC A13/MF A02.

Color illustrations reproduced in black and white.

The Rocky Mountain 1 underground coal gasification (UCG) test was conducted near Hanna, Wyoming during the period January 1986 through March 1988. The report focuses on operations phases that included site selection, facility design, facility construction, well drilling, gasification and environmental monitoring. Two technologies were evaluated as separate modules: the Extended Linked Well (ELW) and the Controlled Retracting Injection Point (CRIP) processes. The test results, along with a discussion of the key test parameters and conclusions of the gasification phase, are provided. A bibliography and schematics are included.

25335 (PB–90-149048/XAB) **Plants materials handbook. Final report.** Soil Conservation Service, Washington, DC (USA). May 1988. 483p. Available from NTIS, PC A21/MF A03.

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Plant Guides have been developed on common species used for mine land revegetation. The guides provide detailed information on adaptation and use of specific plant species. The Plant Guides are organized in three categories: Woody Plants, Forbs, and Grasses. The Handbook also contains State Soil Conservation Service standards and specifications directly relating to seeding grasses, forbs, and woody plant species. The section contains standard and specifications for seeding and associated practices for the following States: Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, and Wyoming.

25336 (PB–90-150467/XAB) **Recommendations on use of OSM's (Office of Surface Mining's) inspection data base. Task 4 report. Final report.** Applied Systems Inst., Inc., Washington, DC (USA). 8 Jul 1981. 29p. Available from NTIS, PC A03/MF A01.

The report culminates an investigation into the suitability of historical mine inspection data for use in Federal oversight of State inspection programs. Beginning with a determination of measurable criteria in the data base, the study included an analysis of the utility of the data for oversight purposes. Those elements found of utility were identified on nonautomated Inspection Activity Summaries and recorded in preparation for inclusion in the automated data base. The report contains a summary of the data available for application to the oversight process, a discussion of limitations in that data, and a set of recommendations on the data's application in a changing regulatory environment.

25337 (PB–90-150491/XAB) **Comparison of soil fertility at surface-mine and reclaimed areas in the United Kingdom and the Western United States. Final report.** Shubert, L.E. North Dakota Univ., Grand Forks, ND (USA). Dept. of Biology. 1989. 15p. Available from NTIS, PC A03/MF A01.

The study examined the soil fertility at unmined, mined and reclaimed sites in England.

25338 (PB–90-150830/XAB) **Furnace sorbent reactivity testing for control of SO2 emissions from Illinois coals. Final report, October 1988-August 1989.** Gullett, B.K.; Briden, F.E. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. Dec 1989. 65p. (EPA–600/2-89/065). Available from NTIS, PC A04/MF A01.

The report gives results of an evaluation of the potential of furnace sorbent injection (FSI) for sulfur dioxide (SO_2) emission control on coal-fired boilers burning coals indigenous to Illinois. Tests were run using four coals from the Illinois Basin and six calcium hydroxide (Ca(OH)2) sorbents, including one provided by the Illinois State Geological Survey (ISGS). The evaluation included pilot- and bench-scale sorbent reactivity testing, sorbent microstructure characterization, and injection ash characterization. Pilot-scale FSI testing gave SO_2 removal greater than 60%, with some tests (including those with the ISGS sorbent) exceeding 70% removal for Ca/S ratios of 2:1. Bench-scale testing of injection at economizer temperatures (538 C) yielded comparable removals of about 55%. X-ray diffraction (XRD) tests of the sorbents showed a strong correlation between three measured crystallite microstructural parameters and sorbent reactivity in the FSI tests. Extraction procedure (EP) toxicity tests with the sorbent injection ash gave values well below Resource Conservation and Recovery Act (RCRA) limits for regulated metals.

25339 (PB–90-151713/XAB) **Design of sediment-control measures for small areas in surface coal mining.** Simons, D.B.; Li, R.M.; Cotton, G.K.; Summer, R.M.; Mussetter, R.A. Simons, Li and Associates, Inc., Fort Collins, CO (USA). Aug 1982. 370p. (OSM–172). Available from NTIS, PC A16/MF A02.

The manual provides design information for four groups of sediment control structures and treatments which are suitable for use on small areas in surface coal mining. A detailed design procedure is given for each group which will estimate the total amount of settleable solids from a small area with a sediment control structure or treatment for a specific design storm. A procedure is also given for estimating the mean annual sediment yield from a small area. Information on design, installation, maintenance and cost is given for each sediment control measure. Methods for determining the maximum allowable area for each sediment control measure and for design of combined sediment control systems are presented. The design procedures contain numerous nomographs, graphs, and worksheets to facilitate the use of the design procedure. The sediment control measures, design procedures, and materials in the manual are applicable to coal bearing regions of the continental Unted States.

25340 (PB–90-153107/XAB) **Manual for backfilling and grading of surface-coal-mining areas.** Skelly and Loy, Harrisburg, PA (USA). 1 Oct 1983. 164p. Available from NTIS, PC A08/MF A01.

The reclamation of surface mined areas satisfies two important objectives. First, reclaimed lands reduce the environmental degradation of the disturbed property as well as the surrounding area by controlling erosion and subsequent sedimentation and by abating hydrologic contamination from exposed toxic materials. Second, reclamation restores the disturbed area to a productive land use. This use could be agricultural, industrial, residential, recreational, or simply the restoration of the land's aesthetic value. Backfilling and grading represent two essential elements in the process of disturbed land reclamation. If these two functions are not properly executed, the success of the entire reclamation operation can be jeopardized. The manual provides assistance in defining backfilling and grading requirements and the options available to efficiently satisfy those requirements.

25341 (PB–90-153180/XAB) **Concepts for protection against catastrophic events from coal mining. Final report.** Kern, J.R.; Stingelin, R.W.; Baker, E.T.; Sparks, J.P. Resource Technologies Corp., State College, PA (USA). 3 Jul 1981. 311p. Available from NTIS, PC A14/MF A02.

The report identifies hazards which may result from coal mining and identifies associated preventive, mitigative, and recovery adjustments. It documents an analysis of the alternatives available to provide protection against catastrophic events. The environmental risks addressed are those that occur beyond the period of time when normal surface and underground mining and reclamation operations have been completed. Residual hazards investigated include: ground water pollution, loss of aquifer, surface water pollution, subsidence, landslides, mine fires, impoundment failures, and mine seal failures. Hazard adjustments investigated include: land use management programs, recovery and restoration programs, insurance programs, special trust funds, bonds and guarantees, disaster assistance programs, regulatory requirements, and litigative approaches. The most effective adjustments were found to be land use control for hazard avoidance through permanent land transfer restrictions imposed as a condition of the mine permit, and local land use regulations. Effective regulation of mine operations to prevent the creation of hazards including the control of final landform was found to be the most efficient adjustment.

25342 (PB–90-153271/XAB) **Environmental reclamation and the coal surface-mining industry. Final report.** Adams, L.W.; Dove, L.E.; Jones, G.E.; Leedy, D.L. National Inst. for Urban Wildlife, Columbia, MD (USA). Apr 1985. 149p. Available from NTIS, PC A07.

Portions of this document are not fully legible.

The present report, based largely on a nationwide survey of the coal mining industry, provides examples of how more than 40 coal mining companies are operating under current regulations to protect the environment and produce coal needed for fuel and other purposes. The report consists largely of information excerpted, quoted, or condensed from comments received from coal mining companies in response to a brief How You Can Help explanatory sheet distributed to them, or data obtained from interviews with mining company and associated scientists, and staff visits to reclamation sites. The sheet listed 14 items on which the Institute sought information. Information provided by the coal mining companies as comments was supplemented in some cases by published reports, which are cited. Although there are references to additional publications, there is no attempt to make an exhaustive review and analysis of the literature. Rather, an attempt is made to convey the feelings of the company respondents with respect to certain regulations and actions taken by their respective companies, whether these feelings show frustration or pride of accomplishment.

25343 (PB–90-153537/XAB) **Control-technology assessment for coal gasification and liquefaction processes: Final study plan.** Enviro Control, Inc., Rockville, MD (USA). Jan 1979. 45p. Available from NTIS, PC A03/MF A01.

See also PB–87-183588.

A plan was detailed for an evaluation of engineering controls used in coal conversion processes. The study evaluated the different control methods, assessed and documented monitoring devices and work practices used to reduce or eliminate worker exposures and emissions, assessed and documented personal protective equipment, and reviewed and assessed the validity and accuracy of existing facility sampling data. Research needs were identified for new control technology and efforts were made to obtain accurate cost data for the design, installation, operation and maintenance of the controls evaluated. The first phase of the study involved a search of the existing literature for pertinent information. The second phase involved an evaluation of field facility surveys of performance and engineering control systems at various locations and analogous industries. Current control devices included valves, flanges, and miscellaneous tanks and storage bins. Various categories of control methods were discussed, including controls which result in containment of the harmful agent; controls which remove or reduce the concentration of the contaminants; controls which isolate or remove the worker from toxic agents; and controls and monitoring systems which warn the worker of hazardous conditions.

25344 (PB–90-157462/XAB) **Use of an in-seam tester to determine effects of bit type on primary dust generation. Report of Investigations/1989.** Sundae, L.S. Bureau of Mines, Twin

Cities, MN (USA). Twin Cities Research Center. 1989. 20p. (BUMINES-RI-9263). Available from NTIS, PC A03/MF A01.

A U.S. Bureau of Mines designed and fabricated in-seam tester (IST), retrofitted with a dust shroud, was used to establish a respirable dust index (RDI) and to determine cutting forces from a variety of bit types in four coal mines and a salt mine. Results from cutting tests at four coal mines showed that radial bits required the lowest cutting force and the least specific energy. Generally, for each conical bit the RDI and cutting force increased when the included bit tip angles increased from 70 degrees to 90 degrees. During field tests it was not possible to measure the total quantity of respirable dust produced by each cut; therefore; attempts were made to determine the amount of dust that became airborne from each test cut. The test results show that the quantity of airborne respirable dust is very erratic and cannot be related to bit type. Two statistical methods were employed to analyze RDI, but no correlation was found between the RDI and bit type. Despite scatter in test results for RDI, significant difference was found in RDI generated in four coal seams. In general, RDI increased with the increased cutting force for each coal seam from mine 1 through mine 4.

25345 (PB-90-157785/XAB) **Reclamation-bond estimation for mine plan review.** Consumer Dynamics, Inc., Rockville, MD (USA). Aug 1981. 98p. Available from NTIS, PC A05/MF A01.

The study was to develop a generic method by which regulatory agencies could verify or, if necessary, estimate reclamation performance bond amounts for proposed coal mining operations. The report assesses the work necessary to reclaim surface and underground coal mines. It reviews how to develop those tasks which are necessary to accurately verify a bond amount; provides a stepwise method of reviewing a mine to find the volumes, haul distances, building sites, etc. and estimate their cost; and assesses sources of unit costs in terms of their usefulness within the estimating framework developed in the study. The study also discusses how representative the costs are of the costs which would actually be incurred in the coal mining regions of the United States, and how often the costs are revised so the report can be properly updated to reflect actual costs.

25346 (PB-90-158403/XAB) **State of the art and guidelines for surface-coal-mine overburden sampling and analysis. Phase 2 report: Recommended guidelines.** Colorado School of Mines, Golden, CO (USA). Nov 1981. 76p. Available from NTIS, PC A05/MF A01.

The study provides recommendations on methods and procedures for use in the premining assessment of surface coal mine overburden. Topics addressed include: overburden drilling and sampling, parameters for predicting quality impact, laboratory methods for analyzing overburden, and procedures for greenhouse testing of overburden. The study is the second phase of a two-part program.

25347 (PB-90-159740/XAB) **Coalbed methane resource and the mechanisms of gas production. Topical report, October 1989.** ICF Resources, Inc., Fairfax, VA (USA). Nov 1989. 128p. Available from NTIS, PC A07/MF A01.

The potential of the coalbed methane resource and the key mechanisms controlling coalbed methane production are defined in tables and figures; and examples are presented of the technology advances required to make production economic from two typical areas. An extensive reference section is included on specific aspects of this resource and its production technology.

25348 (PB-90-160409/XAB) **Hydrologic connection between surface waters and ground waters in the Carbondale Group of Daviess, Gibson, and Pike Counties, Indiana. Final report.** Krothe, N.C. Indiana Univ., Bloomington, IN (USA). Dept. of Geology. 1989. 57p. Available from NTIS, PC A04.

Portions of this document are not fully legible.

The study ascertained the baseline hydrologic conditions in the Pennsylvania Carbondale Group and the effects of coal mining on the groundwater regime. A complete water chemistry for 70 water samples are presented. Sulfur isotope data indicate very similar concentrations in both rock and associated water samples.

0110 Reserves, Geology, and Exploration

Refer also to citation(s) 25396, 25402

0120 Mining

Refer also to citation(s) 25346, 25386, 25387, 26574

25349 (EUR-12326-EN) **Short-term forecasting of methane emission levels using continuously monitored data.** British Coal Corp., Stanhope Bretby (UK). Headquarters Technical Dept. 1989. 72p. Available from Commission of the European Communities, Luxembourg.

The methods of data collection suitable for high quality information required for empirical modelling are outlined. Past work in the field of empirical gas emission models both elsewhere and within HQTD is reviewed. Two methods of modelling the shift by shift variations of methane emission levels are described; the first being a constrained empirical algorithm and the second a theoretical model. Included is a demonstration of how such models can highlight the development of dangerous situations. An assessment is made of the factors to be considered in examining variations in monitored data. An analytical model of gas emissions for non-steady advance rates is appended.

25350 (IOM-TM-89-03) **A study of the formation and control of dust at the ends of highly mechanised longwall faces.** Bradley, A.; Aitken, R.J.; Garland, R.P.; Nicholl, A.G.M.; Weston, P. Canada Centre for Mineral and Energy Technology, Edmonton, AB (Canada). Fuel Research Lab. Aug 1989. 52p. Available from Institute of Occupational Medicine, Edinburgh (UK).

With the advance in technology and advent of more powerful and efficient coal-getting machines it has been necessary in longwall mining to develop higher speed roadway advance techniques. Various new machines and roadway configurations have been tried to increase the rate of advance. This study set out to evaluate airborne dust conditions of a number of face end configurations including retreat faces. Early underground results showed that elevated dust concentrations found in an advance heading could be attributed to the dust from the coal-getting machine 'pluming' along the face track and being drawn into the heading. Model studies of the plume profiles showed that the plume concentration falls approximately exponentially from the coal face to the travelling track with concentrations near to the coal face more than 100 times those in the travelling track. It was also seen that the plume remains essentially intact into the heading. Observations in advance headings demonstrated the efficiency of air curtains, and showed that heading teams are almost always exposed to dust travelling up the heading from behind. They also highlighted the preferred ventilation systems. In-line rippings appeared to pose few problems except those associated with fly-cutting at the face end. Retreat faces also appeared to be associated with few dust control problems. An interesting innovation was the use of a small hand-filled stable which reduced the necessity for fly cutting. It appears that British Coal has both the equipment and technical ability for effective control of the dust at face ends. Further investigation is recommended of the problems of dust pluming and the methods of capturing the plume before it enters the return heading. 13 refs., 13 tabs., 13 figs.

25351 (NERDDP-EG-88-752) **Deep seam-face automation stage 3 - continuous haulage and miner remote control.** McQueen (W.M.) and Co. Pty. Ltd. (Australia). May 1988. 230p. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

Australia's first continuous and flexible face haulage system in the form of 100m long Joy 2 Flexible Conveyor Train (FCT) in conjunction with radio remote-controlled continuous miner and machine-mounted roof-bolting drill rigs (Mining System) has been installed and trialled at Wm. McQueen & Co. Pty. Ltd. - Box Flat No. 9 Colliery, in continuous operation over the period November 1985 to May 1987. This Mining System has, over two panels, successfully produced 198334 tonnes of coal from ISSN production drivage and partial pillar extraction. The FCT has matched or exceeded all of its manufacturers written specifications with only the question of belt life-span yet to be fully answered. The only major

problem during its use was the replacement of the complete belt at 75629 tonnes due to internal delamination and the addition of 2 lengths at 175369 tonnes to try a new batch. At this stage, the fault appears to be a batch quality control problem which will not be repeated since all new belt is obtained elsewhere.

25352 (PB–90-147273/XAB) **Coal-mine road technology: An assessment of references and annotated bibliography, January 1983. Final report.** D'Appolonia Consulting Engineers, Inc., Harrisburg, PA (USA). Jan 1983. 126p. Available from NTIS, PC A07/MF A01.

The report identifies the sources of information regarding specific aspects of the design, construction, maintenance, and reclamation of coal mine roads (haul or access roads) in accordance with Public Law 95-87. Its purpose is to assist persons in the design, construction, and maintenance of coal mine roads by providing a reference list to aid individuals in developing their own libraries regarding various aspects of roads. The report is the result of an intensive literature search (including use of computerized information retrieval systems as well as published bibliographies). Guidelines and requirements for design, construction, and maintenance of coal mine roads have been developed by the Office of Surface Mining as well as state regulatory authorities. The information provides operating standards or design guidelines with limited information regarding the actual design process.

25353 (PB–90-147299/XAB) **Evaluation of the highwall problem. Final report.** Judd, W.R.; Altschaeffl, A.G. Purdue Univ., Lafayette, IN (USA). School of Civil Engineering. Nov 1982. 46p. Available from NTIS, PC A03/MF A01.

Public Law 95-87 mandates the elimination of permanent highwalls. Therefore at the request of the Office of Surface Mining, the study was undertaken to determine if design procedures are available that would assure the stability of permanent highwalls of rock. A search of some 1800 references that appeared relevant resulted in the evaluation of 118 of these that were directly relevant to the highwall problem. Available theories and application of theory to actual performance were evaluated. The conclusion is that some design procedures have had satisfactory results but they tend to be site specific. Therefore, it is recommended that permanent highwalls be allowed providing specific substantiating data is provided and approved by a peer review group.

25354 (PB–90-147315/XAB) **Investigation of blasting vibrations above abandoned underground coal mines. Final report.** Siskind, D.E.; Crum, S.V.; Otterness, R.E.; Kopp, J.W. Office of Surface Mining Reclamation and Enforcement, Washington, DC (USA). 1 Sep 1987. 129p. Available from NTIS, PC A07/MF A01.

The Bureau of Mines performed a comparative study of nine Indiana surface coal mine sites at eight different mines to determine if the presence of near-surface underground abandoned workings resulted in the generation of adverse long-duration, low-frequency blast vibrations. Bureau researchers used extended seismic arrays to identify the vibration characteristics generated within a few tens of feet of the blasts and also as modified by the propagating medium at distances over 1 mile. Production and specially fired single-charge blasts allowed the determination of natural ground frequency and also the influence of the initiation delay timing. Vibration amplitudes from the production blasts at all sites exceeded historical norms, particularly at the greater distances. This contrasts with the near-normal, single-charge blasts. Apparently, between-hole time delays were insufficient to separate vibrations from adjacent charges for the low-frequency waves present at these sites.

25355 (PB–90-147323/XAB) **Development of a coal surface-mine-monitoring capability utilizing Landsat satellite technology. Final report.** Inglis, M. New Mexico Univ., Albuquerque, NM (USA). Technology Application Center. 21 Jun 1980. 48p. Available from NTIS, PC A03/MF A01.

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The purpose of the investigation was the continued development of the STANSORT II software program, a satellite oriented multispectral software package, and transfer of the software to the Technology Application Center as an established applications group. The group could then provide direct support services in the monitoring of coal surface mining to the Office of Surface Mining. Specifically the grant provided for: completion of necessary software developments of STANSORT II and transfer of that software to a small, dedicated computer; establishing the Technology Application Center with the ability to use the software; demonstration of the STANSORT II monitoring capability to date within a surface mine in Oklahoma; and satisfactorily classify the Navajo coal surface mine in northwestern New Mexico previously classified by STANSORT software operating on a large computer.

25356 (PB–90-148255/XAB) **Handbook for permit-application and mine-plan review procedures for coal-mining operations on Federal lands.** Hittman Associates, Inc., Columbia, MD (USA). 8 Aug 1980. 254p. Available from NTIS, PC A12/MF A02.

The handbook provides a description of the regulatory procedures governing the process for making applications for permits to mine coal on Federal lands and for the review, approval, and disapproval of the mining plan and the associated permit application by the Secretary of the Interior and the Director of the Office of Surface Mining, respectively.

25357 (PB–90-148420/XAB) **Surface-mine operator's manual. Final report.** Applied Science Associates, Inc., Pittsburgh, PA (USA). 1989. 324p. Available from NTIS, PC A14/MF A02.

The manual was developed primarily for surface coal mining operators and their consultants, to help them understand and comply with the requirements of the Surface Coal Mining and Reclamation Act of 1977 and the regulatory programs associated with the Act. It is intended to serve as a reference tool for operators during coal exploration, the application process, active mining, reclamation activities, and bond release. The manual will also be useful to Federal and State personnel responsible for reviewing permit applications (especially in reviewing mining and reclamation plans for compliance with performance standards).

25358 (PB–90-148487/XAB) **Engineering analysis and evaluation of the Centralia mine fire. Volume 1.** GAI Consultants, Inc., Monroeville, PA (USA). Jul 1983. 215p. Available from NTIS, PC A10/MF A02.

The report presents the results of a study of the Centralia, PA mine fire. Project activities included a review of existing data and background information on the fire, including previously attempted control measures; a review of the geology, mining and hydrology in the Centralia area; an evaluation of the physical character of the overburden and the identification of thermal effects; a ventilation study of the mine workings in which the fire is actively burning and an analysis of the apparent progression of the fire with time; and a review of proven and experimental methods for containing and extinguishing underground mine fires and the formulation of possible courses of action that might be considered for dealing with the fire.

25359 (PB–90-150459/XAB) **Engineering analysis and evaluation of the Centralia mine fire. Executive Summary. Final report.** . GAI Consultants, Inc., Monroeville, PA (USA). 1989. 16p. Available from NTIS, PC A03/MF A01.

The report presents the results of a study of the Centralia, PA mine fire. Project activities included a review of existing data and background information on the fire, including previously attempted control measures; a review of the geology, mining and hydrology in the Centralia area; an evaluation of the physical character of the overburden and the identification of thermal effects; a ventilation study of the mine workings in which the fire is actively burning and an analysis of the apparent progression of the fire with time; and a review of proven and experimental methods for containing and extinguishing underground mine fires and the formulation of possible courses of action that might be considered for dealing with the fire.

25360 (PB–90-150574/XAB) **Coal-mine road technology: An assessment of references and annotated bibliography, June 1982. Final report.** D'Appolonia Consulting Engineers, Inc., Harrisburg, PA (USA). Jun 1982. 125p. Available from NTIS, PC A06/MF A01.

Portions of this document are not fully legible.

The report identifies the sources of information regarding specific aspects of the design, construction, maintenance, and reclamation

of coal-mine roads (haul or access roads) in accordance with Public Law 95-87. Its purpose is to assist persons in the design, construction, and maintenance of coal mine roads by providing a reference list to aid individuals in developing their own libraries regarding various aspects of roads, particularly in subject areas outside their specialty, and also to evaluate the availability of information in various subject areas.

25361 (PB–90-151440/XAB) **Engineering and design manual for disposal of excess spoil. Final report.** Homquist, D.V.; McOmber, R.M.; Roberts, J.M. CTL/Thompson, Inc., Denver, CO (USA). 1989. 296p. Available from NTIS, PC A13/MF A02.

The Manual presents procedures for use in evaluating, designing, constructing, and monitoring excess spoil disposal structures. The document primary intention is to serve as a guide for the safe disposal of excess spoil materials. The format, terminology, and contents have been prepared for the professional engineer who designs structures and the technical reviewer with a background in civil engineering. The manual relates state-of-art engineering and design practices to the disposal of excess spoil and provides analysis guidelines and procedures. The document provides the design professional with a source of information and guidelines consistent with good engineering practice, environmental concerns, and regulatory constraints. A certain fundamental understanding of mining procedures, geotechnical engineering, slope stability analysis, and hydrology is assumed.

25362 (PB–90-153156/XAB) **Coal-mine road technology: An assessment of references and annotated bibliography. Final report.** D'Appolonia Consulting Engineers, Inc., Harrisburg, PA (USA). Jan 1983. 123p. Available from NTIS, PC A06/MF A01.

The report identifies the sources of information regarding specific aspects of the design, construction, maintenance, and reclamation of coal mine roads (haul or access roads) in accordance with Public Law 95-87. Its purpose is to assist persons in the design, construction, and maintenance of coal mine roads by providing a reference list to aid individuals in developing their own libraries regarding various aspects of roads, particularly in subject areas outside their specialty, and also to evaluate the availability of information in various subject areas.

25363 (PB–90-153651/XAB) **Certification test for blaster-in-charge surface coal mines. Form B.** American Insts. for Research, Washington, DC (USA). Nov 1989. 17p. Available from NTIS, PC A03/MF A01.

The certification test for blaster-in-charge licensing for surface coal mines is presented.

25364 (PB–90-155425/XAB) **Effect of energy and impact direction on coal fragmentation. Report of Investigations/1989.** Voltz, J.I. Bureau of Mines, Twin Cities, MN (USA). Twin Cities Research Center. 13 Sep 1988. 24p. (BUMINES-RI–9260). Available from NTIS, PC A03/MF A01.

Library of Congress catalog card No. 88-607919.

The U.S. Bureau of Mines has conducted fundamental coal fragmentation studies to evaluate the effects of impact energy and direction of bedding planes on dust generation, size distribution, and impact-output energy relationships. Product size distributions were obtained for the fragmented samples by screening to minus 150 mesh. The minus 150-mesh fines were analyzed with a light scattering photometer with a measurement range of 176 to 1.9 micrometers. Increased input energy produced a significant increase in the weight of plus 3/8-in material for impact perpendicular to the bedding planes. no significant trend was observed for parallel impact. Impact direction had little influence on dust size distribution, and input versus output energy relationships. As expected, total airborne dust measured at time of impact and percent particulates below 11 micrometers in size generally increased with increased input energy for both directions of impact. Energy used for sample fragmentation increased with increased energy input.

25365 (PB–90-156266/XAB) **Advanced guidelines for performance testing of two-legged longwall shields. Information Circular/1989.** Barczak, T.M. Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center. Feb 1989. 257p. (BUMINES-IC–9231). Available from NTIS, PC A12/MF A02.

Library of Congress catalog card No. 89-600167.

The report is intended to assist coal mine operators in the selection of longwall supports by providing advanced guidelines for performance testing and standardized test documentation to facilitate support comparisons. These advanced guidelines culminate in a series of proposed tests to evaluate support resistance characteristics, stiffness characteristics, leg mechanics, stability, load transfer mechanics, and structural integrity. The Bureau has conducted extensive studies on shield mechanics to identify boundary conditions that induce loading in support components, which is often not included in current testing techniques. The report discusses influential parameters that affect support behavior and provides insight into how components are loaded and what conditions produce the most severe loading. Testing philosophies and techniques in both active and static frames are discussed. Proper methods for determining support resistance are described and instrumentation requirements for advanced performance testing are provided.

25366 (PB–90-157439/XAB) **Hillseam geology and roof instability near outcrop in eastern Kentucky drift mines. Report of Investigations/1989.** Sames, G.P.; Moebs, N.N. Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center. 1989. 40p. (BUMINES-RI–9267). Available from NTIS, PC A03/MF A01.

Library of Congress catalog card No. 89-600173.

The U.S. Bureau of Mines study was conducted in eastern Kentucky drift mines as part of an ongoing research program to characterize the outcrop barrier zone. Hillseams were identified as the dominant geologic cause of roof instability unique to the outcrop barrier zone, with many roof fall injuries and fatalities attributed to them. Hillseam is the eastern Kentucky miners' term for weather-enlarged tension joints that occur in shallow mine overburden where surface slopes are steep. Hillseams are most conspicuous within 200 ft laterally of a coalbed outcrop and under 300 ft or less of overburden. Hillseams form by stress relief, and therefore tend to parallel topographic contours and ridges. They can intersect at various angles, especially under the nose of a ridge, and create massive blocks or wedges of roof prone to failure. Examples of hillseams are described in both outcrop and coal mine roof to establish their geologic character and contribution to roof failure.

25367 (SEMR–33) **Fuel peat for residential furnaces.** Saskatchewan Dept. of Energy and Mines, Regina, SK (Canada). [1984]. vp. (CE–02928). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper is the final report of a final peat demonstration test. The main objective of this project was to determine the suitability of peatland, peat type, and climate/weather in the Buffalo Narrows area for the pruduction of fuel peat using a 25 ha demonstration bog as a test site. Other topics include: testing of a conventional fuel peat mining method, namely extruded sod peat; obtaining preliminary information on peat production rates and costs to assist in preparing an estimated cost of mining for a commercial-size operation; determining the suitability of sods as a fuel for domestic heating in terms of handling, storage, combustion characteristics, efficiency, and burn rate; evaluating the general suitability of both Canadian and Finnish domestic furnaces for burning sod peat. Also included are enevironmental considerations, and alternaive peat products and energy options.

0130 Transport, Handling, and Storage

Refer also to citation(s) 25302

25368 (DOE/PC/90961–T9) **Laser velocimeter measurements of multiphase flow of solids: Final report, September 1986–April 1989.** Kadambi, J.R.; Chen, R.C.; Bhunia, S. Case Western Reserve Univ., Cleveland, OH (USA). [1989]. 114p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-86PC90961. Order Number DE90007604. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

A unique refractive index matched facility for studying solid-liquid multiphase flow has been developed. The refractive index matching of the solid and the liquid allows the use of non-intrusive Laser

Doppler Velocimetry (LDV) to measure the solid and the liquid velocities. These measurements will be useful in developing a better understanding of solid-liquid flows, especially solid-liquid and solid-solid interactions. Silica gel and 50% sodium iodide solution in water (refractive index ≈1.443) are used as the refractive index matched solid and liquid respectively. A two color back scatter mode LDV is used for making velocity measurements. Tests were conducted in solid-liquid slurries with volumetric solid concentration levels of 5% and 15% in the Reynolds number (Re) range of 400 to 9200. Silica gel particles of mean diameter 40 microns were used. Measurements included mapping of the solid and liquid velocities and obtaining the pressure drop data. Signal processing technique utilizing histogram of velocity measurements made at a point and signal amplitude discrimination was successfully used for differentiating between solid and liquid velocities. 34 refs., 61 figs., 5 tabs.

0140 Combustion

Refer also to citation(s) 25302, 25367, 25404, 25732, 25733, 25931, 25944, 26051

25369 (ANL/CNSV-TM–186, pp. 21-38) **Coal combustion in oxygen and recycled flue gas mixtures: Experimental evaluation and boiler performance prediction.** Payne, R. (Energy and Environmental Research Corp., Irvine, CA (USA)); Richter, W.; Abele, A. Argonne National Lab., IL (USA). Jun 1988. (CONF-8703302–: Workshop on recovery and use of waste CO_2 in enhanced oil recovery, Denver, CO (USA), 19-20 Mar 1987). In *Recovery and use of waste CO_2 in enhanced oil recovery. Proceedings.* Order Number DE89002803. Available from NTIS, PC A06/MF A01.

Coal combustion in mixtures of pure oxygen and recycled flue gases, instead of air, has been proposed for application to existing utility boilers as a means of generating carbon dioxide for use in enhanced oil recovery operations. In such combustion retrofit applications it is desirable to maintain the boiler performance characteristics for which the unit was designed, and heat transfer is of paramount importance. In this study an experimental evaluation of the O_2 recycle gas process has been conducted at 10×10^6 Btu/hr to investigate overall combustion and heat transfer performance. Computational heat transfer modeling has also been applied to a specific coal-fired utility boiler for the prediction of impacts on furnace and boiler performance. The use of dry or wet flue gas recycle streams has been investigated, and parametric studies conducted to identify the flue gas recycle/input O_2 ratios which most closely simulate operation on air. Results from the study have shown that optimum wet and dry recycle ratios do exist, at which combustion and heat transfer performance changes are minimal compared to operation on air, and where the capacity for utility steam generation can be maintained. However, the results indicate that optimum recycle conditions will depend upon both the scale and specific thermal characteristics of the furnace system under consideration.

25370 (DOE/METC–89/6099, pp. 177-182) **High temperature interaction of SO_2 with oxide sorbents.** Seehra, M.S. (West Virginia Univ., Morgantown (USA)); Gopalakrishnan, R. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The overall goal of this project is to provide fundamental information on the mechanism of sulfur capture in the interaction of SO_2 and O_2 with calcined $CaCO_3$ and $MgCO_3$ near 700 C. The novel feature of this project is the use of in-situ FTIR and ESR spectroscopies for the determination of not only the kinetics but also the nature of the products of the interaction at different temperatures and stages of the reaction. The study included the following major components: 1. Initial experiments on the characterization of MgO and dolomite using ESR spectroscopy. 2. In-house construction of a versatile high vacuum system which can handle corrosive gases such as SO_2 and H_2S. 3. Acquisition of a FTIR spectrometer, and a high vacuum, high pressure IR cell for in-situ measurements. 4. Experiments on the characterization of chemical species formed during the high temperature interaction of SO_2 with MgO and CaO. 5. Kinetics of the high temperature interaction of SO_2 and O_2 on CaO, MgO, CaO + MgO mixture and calcined dolomite. Tasks 1 through 4 and a part of task 5 have been completed. Results are presented.

25371 (DOE/METC–89/6099, pp. 204-211) **Contaminant release and removal - NOx studies.** Casleton, K.H. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objective of these studies is to investigate the chemical kinetics associated with NOx formation and control mechanisms to support the development of NOx control strategies for advanced heat engine systems. Of particular interest are means to optimize staged combustion (air injection), reburning (fuel injection), and sorbent (e.g. ammonia or cyanuric acid) injection. The initial literature search and data evaluation activities have identified large gaps in the knowledge of the rates of important fundamental processes at conditions relevant to NOx formation and control processes. Experimental studies are performed using a high-temperature photochemistry technique wherein a radical species of interest is generated via the photolysis of an appropriate precursor molecule. The reaction of these radicals with a reactant gas is monitored by following the decay of the radical population via laser induced fluorescence. Using this method, absolute rate coefficients for the reaction of CN radicals with H_2 have been measured as a function of temperature over the range 368 - 1333 K. CN radicals were generated by 193 nm excimer laser photolysis of dilute C_2N_2/Ar mixtures and monitored by laser induced fluorescence near 386.7 nm under pseudo-first order conditions. The overall rate coefficients for CN consumption by H_2 can be fit to an Arrhenius expression of the form $k(T) = 6.6 \times 10^{-11} \exp(-2600K/T)$ cm^3 $molecule^{-1}$ s^{-1} with statistical uncertainties of ± 28% at 368 K and ± 15% at 1333 K. In addition, limited studies of similar reactions of CN with methane and ethane have been performed.

25372 (DOE/METC–89/6099, pp. 230-240) **Determination of the fate of alkali species in advanced coal conversion systems.** Krishnan, G.N. (SRI International, Menlo Park, CA (USA)); Wood, B.J.; Brittain, R.D.; Lamoreaux, R.H.; Platz, R.M.; Smith, G.P. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The general objective of this program is to understand the chemical and physical phenomena that lead to the formation of corrosive alkali species in coal combustion and gasification processes. The research effort is directed specifically toward identification and quantification of sodium species and their interaction with other gases and particles present in a pressurized-fluidized bed reactor (PFBR). A 200-cm long pressure vessel has been fabricated that can accomodate a fluidized bed reactor of 6.3 to 15-cm diameter. Near the top of the vessel ports are situated for mass spectrometric analysis, laser induced fluorescence analysis, and particle sampling. A compact chamber with three vacuum stages has been designed and fabricated to sample gases from PFBR as a molecular beam and analyze them with a mass spectrometer. A sensitivity of 1 ppm is feasible with this design and in addition, the detected species will closely reflect the chemical states within the reactor. A 0.5-cm diameter isokinetic probe has been designed to sample particles in the range of 0.05 to 10 μm. An alkali vapor absorbent bed, situated concentric to the probe tube, removes alkali vapor species by diffusion at about 800 to 1000 C, and thus, prevents condensation of alkali vapors on the particles as they cool down. A cascade impactor attached to the end of the probe will collect and sort the particles by sizes. Particles larger than 10 μ will be collected in a cyclone. A two-photon laser-induced fluorescence technique is being evaluated for determining sodium atom detection without interference from background emissions and self absorption of fluorescence radiation. A comprehensive literature survey has been performed of available models of coal combustion and gasification processes with particular emphasis on the formation and fate of alkali species.

25373 (DOE/METC–89/6108-Vol.2) **Proceedings of the advanced research and technology development direct utilization, instrumentation and diagnostics contractors review meeting: Volume 2.** Geiling, D.W. (USDOE Morgantown Energy Technology Center, WV (USA)); Goldberg, P.M. (eds.). USDOE Morgantown Energy Technology Center, WV (USA); USDOE Pittsburgh Energy Technology Center, PA (USA). Oct 1989. 350p. Sponsored by U.S. DOE Fossil Energy. (CONF-891046–: Advanced research and technology development, Morgantown, WV (USA), 3-5 Oct 1989). Order Number DE90000425. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

The 1989 Advanced Research and Technology Development (AR&TD) Direct Utilization, and Instrumentation and Diagnostics Contractors Review Meeting was held October 3–5, 1989, at the Lakeview Resort and Conference Center in Morgantown, West Virginia. The meeting was sponsored by the US Department of Energy (DOE), Office of Fossil Energy, and the Pittsburgh and Morgantown Energy Technology Centers. Each year the meeting provides a forum for the exchange of information among the DOE AR&TD contractors and interested parties. This year's meeting was hosted by the Morgantown Energy Technology Center and was attended by 230 individuals from industry, academia, national laboratories, and other Governmental agencies. Papers were presented on research related to pyrolysis, combustion phenomena, instrumentation, components, coal beneficiation, ash behavior, heat engines, fluidized bed combustion and gas stream cleanup. This Volume 2 contains reports of sessions 7–10 and the poster session. Individual projects are processed separately for the data bases.

25374 (DOE/METC–90/6108-Vol.1) **Proceedings of the advanced research and technology development direct utilization, instrumentation and diagnostics contractors review meeting: Volume 1.** Geiling, D.W. (USDOE Morgantown Energy Technology Center, WV (USA)); Goldberg, P.M. (eds.). USDOE Morgantown Energy Technology Center, WV (USA); USDOE Pittsburgh Energy Technology Center, PA (USA). Oct 1989. 357p. Sponsored by U.S. DOE Fossil Energy. (CONF-891046–: Advanced research and technology development, Morgantown, WV (USA), 3-5 Oct 1989). Order Number DE90000424. Available from NTIS, PC A15/MF A01 - OSTI; GPO Dep.

The 1989 Advanced Research and Technology Development (AR&TD) Direct Utilization, and Instrumentation and Diagnostics Contractors Review Meeting was held October 3–5, 1989, at the Lakeview Resort and Conference Center in Morgantown, West Virginia. The meeting was sponsored by the US Department of Energy (DOE), Office of Fossil Energy, and the Pittsburgh and Morgantown Energy Technology Centers. Each year the meeting provides a forum for the exchange of information among the DOE AR&TD contractors and interested parties. This year's meetings was hosted by the Morgantown Energy Technology Center and was attended by 230 individuals from industry, academia, national laboratories, and other Governmental agencies. Papers were presented on research related to pyrolysis, combustion phenomena, instrumentation, components, coal beneficiation, ash behavior, heat engines, fluidized bed combustion and gas stream cleanup. This volume contains reports of the first six sessions. Individual projects are processed separately on the data bases.

25375 (EUR–12360-EN) **Minimising erosion in coal-fired boilers.** British Coal Corp., Stoke Orchard (UK). Coal Research Establishment. 1989. 95p. Available from Commission of the European Communities, (Luxembourg).

Metal loss has occurred in varying degrees on the walls and in-bed tubes of the UK shallow fluidised bed boilers. This metal loss has been caused by the wearing action of the sand and ash particles and occurs mainly in the region between the static bed surface (before fluidisation) and that of the fully fluidised bed. Wastage rates of up to 3 mm/1000 hours have been found on the containment walls and in excess of 1 mm/1000 hours from the heat transfer tubes. Localised wear at the entry to certain smoke tubes in conventional boilers has also been identified. The research programme, initiated to tackle these problems, was carried out in collaboration with the UK boiler manufacturer Foster Wheeler Power Products Limited. The following test areas were addressed: cold modelling and mechanistic studies; materials studies; assessment of field data; hot testing; and smoke tube studies. A range of measuring and flow visualisation techniques have been developed to study wear in laboratory units and commercial boilers. The findings are discussed. (a) The major factors influencing tube wear have been identified and design solutions developed. (b) Wall wear has been successfully eliminated by the installation of metal shelving or refractory coating. (c) Stainless steels have been shown to provide no improvement in wear resistance, compared with mild steel, at the conditions employed in UK industrial boilers. However, a number of surface treatments gave encouraging performance and are worthy of further investigation. It is concluded that, provided boiler makers and their customers implement the guidelines outlined, wear within the bed of FBC boilers and boiler smoke passes can be eliminated or reduced to an acceptable level. 23 refs., 26 figs., 11 tabs.

25376 (SAND–89-8235, pp. 9-30) **Coal combustion science, Task 1: Coal devolatilization.** Fletcher, T.H.; Hardesty, D.R. Sandia National Labs., Livermore, CA (USA). May 1989. In *Coal combustion science quarterly progress report, October–December 1988.* Order Number DE89012816. Available from NTIS, PC A04/MF A01.

The objective for this project is to characterize the physical and chemical processes which comprise the early devolatilization phase of coal combustion as a function of coal type, heating rate, particle size and temperatures, and gas phase temperature and oxygen concentrations. These objectives are met by conducting basic research in 5 subtask areas as follows: (1) determination of total devolatilization rates; (2) investigation of physical structure changes during pyrolysis; (3) investigation of changes in chemical structure during pyrolysis; (4) determination of nitrogen and sulfur release rates; and (5) development of engineering models of devolatilization. Each of these subtasks are briefly described. The paper concentrates on the progress made under subtask 5. The chemical percolation devolatilization (CPD) model includes a dynamic variable to describe the hydrogen available for stabilization of side chains and the formation of tar. The model is now capable of describing the effects of heating rate on rates and yields of pulverized coal devolatilization. In addition, a complete set of devolatilization data was obtained for 2 coals: PSOC-1507D North Dakota Beulah lignite and PSOC-1445D New Mexico Blue subbituminous coal. The data include measured particle temperatures, sizes, and velocities in the Sandia Coal Devolatilization Laboratory in 100% nitrogen at 2 different gas temperature conditions (maximum gas temperatures of 1250 K and 1050 K). Solid samples were collected at different residence times in the flow reactor, and were analyzed for elemental composition of major elements (C, H, N, O, and S) and for elemental composition of the ash (Ti, Al, Si, Fe, Na, Ca, K, and Mg). Apparent densities were also measured using a volumetric technique.

25377 (SAND–89-8235, pp. 31-54) **Coal combustion science, Task 2: The rates and mechanisms of coal char combustion.** Mitchell, R.E.; Hardesty, D.R. Sandia National Labs., Livermore, CA (USA). May 1989. In *Coal combustion science quarterly progress report, October–December 1988.* Order Number DE89012816. Available from NTIS, PC A04/MF A01.

The objective of this study is to characterize the physical and chemical processes involved during coal char combustion as a function of coal type, particle size and temperature, and gas temperature and composition. The experimental endeavor provides the data required to develop a predictive model of the char combustion process. Specific objectives are being met by conducting basic research in 5 subtask areas as follows: (1) determination of apparent char particle burning rates; (2) determination of the intrinsic chemical reactivity of chars; (3) determination of nitrogen and sulfur release rates; (4) investigation of char fragmentation phenomena; and (5) development of engineering models of coal char combustion. Progress made on four of the subtasks (1,2,3,5) is described.

25378 (SAND–89-8235, pp. 55-67) **Coal combustion science, Task 3: The fate of mineral matter.** Baxter, L.L.; Hardesty, D.R. Sandia National Labs., Livermore, CA (USA). May 1989. In

Coal combustion science quarterly progress report, October–December 1988. Order Number DE89012816. Available from NTIS, PC A04/MF A01.

The objectives of this research are (1) to establish a quantitative understanding of the mechanisms and the rates of transformations of mineral matter in coal combustion environments as a function of coal type, particle size and temperature, initial forms and distribution of mineral species in the coal, and local gas temperature and composition and (2) to determine the relative importance of fragmentation in the evolution of particle and fly ash size distributions during coal combustion. These objectives are being met by conducting research in 2 subtask areas as follows: (1) particle fragmentation: the influence on fly ash size distribution; and (2) mineral matter transformations during coal combustion. This report concentrates on the progress on the second subtask. Experimental studies are presented of the size distributions of silica and pyrite particles, which are retained within (or on the surface of) the reacting char particles, as a function of residence time. Pyrite and silica are the 2 most prevalent minerals in the samples of Illinois #6 coal used in this study. The chemical decomposition products of pyrite are also presented. The size and elemental composition of both the interior and surface mineral grains are reported here. The focus of this work is on the development of the psd of the inorganic grains during particle heatup, devolatilization and the initial stages of heterogeneous reaction. Although extensive fragmentation of these inorganic grains is observed, within the coal/char particles, there is no evidence that silica or pyrite or any of their decomposition products are released from the coal particles during the residence times considered.

25379 Coal-water slurry combustion in gas turbines. Staub, F.W. (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Center); Kimura, S.G.; Spiro, C.L.; Horner, M.W. 9p. American Society of Mechanical Engineers, New York, NY (USA) (1988). (CONF-880607–: 33. ASME international gas turbine and aeroengine congress and exposition, Amsterdam (Netherlands), 5-8 Jun 1988).

88-GT-94.

This paper presents preliminary results of a program to investigate the key technologies for burning coal-water slurries in gas turbines. Results are given for slurry atomization and combustion testing and analyses performed at conditions typical for gas turbine applications. Significant progress has been made toward the understanding of slurry combustion and ash deposition phenomena. Confidence has been gained to the extent where elimination of a supplementary pilot fuel can now be projected.

25380 Staged combustor evaluation of low rank coal fuels. Rosfjord, T.J. (United Technologies Research Center, East Hartford, CT (USA)). 8p. American Society of Mechanical Engineers, New York, NY (USA) (1988). (CONF-880607–: 33. ASME international gas turbine and aeroengine congress and exposition, Amsterdam (Netherlands), 5-8 Jun 1988).

88-GT-91.

The author discusses the combustion characteristics of fuels derived from low rank coals evaluated at firing conditions representative of an industrial gas turbine engine. Data have been acquired for five fuels containing subbituminous coal and one using a lignite. The subbituminous fuels were coal-water mixtures differing in either the coal processing or coal loading. One slurry was based on minimally-processed coal which contained relatively high ash and internal moisture levels; the coal loading was limited to 42 pct to sustain acceptable handling. The other four slurries presented different loading of an improved-quality form of the same parent coal; slurry loadings up to 55 pct were achieved, providing nearly 50-pct greater heating value than the minimally-processed fuel. The lignite coal was also processed to produce an improved-quality slurry. Attempts to deliver and combust powdered, subbituminous coal were not successful. All tests were performed in a combustor configured to achieve geometrically separated zones of fuel-rich and fuel-lean combustion. Test results indicate a lower limit of fuel energy density as necessary to sustain stable combustion.

25381 U.S. Department of Energy coal-fueled gas turbine program: A status report. Bryam, J.W. Jr. (USDOE Morgantown Energy Technology Center, WV (USA)); Rekos, N. 6p. American Society of Mechanical Engineers, New York, NY (USA) (1988). (CONF-880607–: 33. ASME international gas turbine and aeroengine congress and exposition, Amsterdam (Netherlands), 5-8 Jun 1988).

88-GT-86.

Beginning in 1982, the Department of Energy (DOE), through the Morgantown Energy Technology Center (METC), has been conducting research for the purpose of verifying the feasibility of using coal fuels in heat engine applications. The heat engines of primary concern are the gas turbine and the diesel engine. The overall program objective is to develop the technology base for an environmentally sound, integrated heat engine system which will produce cost-competitive energy from coal. This paper presents the status of the gas turbine portion of this program.

25382 Combustion characteristics of mild-gasification chars. Daw, G.S. (Oak Ridge National Laboratory, Oak Ridge, TN (USA)). *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 34(4): 1256-1263 (1989).

Chars from low-temperature pyrolysis of two high-volatile coals in two processes under development were tested for combustibility by thermal gravimetric analysis and a fixed-bed reactor method. A combined Arrhenius rate expression was derived. It was concluded that the chars were suitable for combustion in boilers etc. using certain firing systems. 13 refs., 4 figs., 4 tabs.

0150 Economic, Industrial, and Business Aspects

Refer also to citation(s) 25294, 25295, 25367, 25504, 25925

25383 (PB–90-148685/XAB) **Computer model study: An analysis of the Nephew/Spore model for determining costs of cost of coal mining in Appalachia. Final report.** Nephew, E.A.; Spore, R.L. International Business Services, Inc., Washington, DC (USA). 6 Jun 1980. 82p. Available from NTIS, PC A05/MF A01.

Portions of this document are not fully legible.

The study determined whether the model developed to study Costs of Coal Surface Mining and Reclamation in Appalachia was capable of being responsive to the needs of the Office of Surface Mining for projecting the extraction costs of coal in support of the Small Operator Assistance Program. The study analysis validated the model and adapted the model to specific small operator needs in terms of user flexibility. Based on the analysis and model enhancements approach used by the study, three primary recommendations are made: Validate the model with live cost and performance data to determine potential viability for small operator assistance; Enhance the model to provide greater flexibility and ease of user support; and field test the model through regional offices of the Small Operator Assistance Program.

25384 (PB–90-153628/XAB) **Economic evaluation of OSM (Office of Surface Mining) hydrology, geology, and air resources regulations. Task Order No. 1. Sedimentation ponds. Final report.** Hittman Associates, Inc., Columbia, MD (USA). Dec 1981. 40p. (OSM–112). Available from NTIS, PC A03/MF A01.

The report presents an economic evaluation of potential costs and benefits and the potential effects on small business entities associated with implementing rulemaking changes in the Sedimentation Ponds Section 715.17, Protection of the hydrologic system; Section 816.42, Hydrologic balance: Water quality standards and effluent limitations; and Section 816.46, Hydrologic balance: Sedimentation ponds of the permanent regulatory program issued under the Surface Mining Control and Reclamation Act of 1977.

25385 (PB–90-154717/XAB) **Economic assessment of the impact on coal production due to enforcement of the Surface Mining Control and Reclamation Act of 1977. Cost report. Final report.** Orkand Corp., Silver Spring, MD (USA). 12 Nov 1980. 11p. Available from NTIS, PC A03/MF A01.

The report summarizes the efforts made in the cost analysis portion of the 'Economic Assessment of the Impact on Coal Production Due to Enforcement of the Surface Mining Control and Reclamation Act (SMCRA) of 1977. The objective of the cost analysis portion of the study was to supplement the study's examination of the benefits of SMCRA with an analysis of the costs of SMCRA as based on industry experience and data. The analysis

involved the development and field test of a methodology for constructing estimates of the costs of complying with regulations at individual surface coal mines.

0160 Health and Safety

Refer also to citation(s) 25343, 25359

25386 (IOM-TM–89-04) **Permissible wearing times for rescue personnel using a new self-contained breathing apparatus.** Graveling, R.A.; Miller, B.G. Institute of Occupational Medicine, Edinburgh (UK). Aug 1989. 51p. Available from Institute of Occupational Medicine, Edinburgh (UK).

British Coal's Central Mines Rescue Service has developed a new compressed oxygen breathing apparatus, the Selected Elevated Flow Apparatus (SEFA) to improve the wearability/tolerability of self-contained breathing apparatus in terms of breathing resistance and inspiratory temperature. Climate chamber studies were carried out of the physiological responses to wearing the SEFA apparatus in the heat, to determine new permissible working time charts. Ninety-three subjects completed a total of 428 wearings. The data for all wearings were summarized either to the time at which core temperature, heartrate or personal discomfort led to withdrawal of the subject from the chamber (withdrawal time), or to the limiting time (60 or 120 minutes, depending on selected flowrate) at which the wearing was terminated if withdrawal had not occurred. Plots of the 'limiting times' against climatic temperature were analysed statistically; As a result of this analysis, it was decided by British Coal Mines Rescue and Medical Services, in consultation with the Mines and Quarries Inspectorate and the Institute, to adopt working times which combined the two data from this and the previous trial. Support for this decision was provided by the lack of any evidence of heat-related problems with the operational use of the Proto apparatus since the introduction of the charts more than 30 years ago. A chart of permissible wearing times for the SEFA apparatus was produced in accordance with this decision. 22 refs., 13 tabs., 11 figs.

25387 (IOM-TM–89-09) **Improved hearing protection in a mining environment.** Best, C.F. (Institute of Occupational Medicine, Edinburgh (UK)); Coleman, G.J.; Graveling, R.A.; Simpson, G.C.; Talbot, C.F. Institute of Occupational Medicine, Edinburgh (UK). Jun 1989. 70p. Available from Institute of Occupational Medicine, Edinburgh (UK).

Conventional hearing protectors, while adequate for basic hearing conservation in mine operations, are less than ideal in terms of related requirements such as signal audibility and comfort acceptability. A design specification for a hearing protector ideally suited to mineworkers' requirements was produced from general guidelines developed in a previous project and initial studies in this project covering comfort and acceptability. The crucial element in the design specification, which is not achieved in any conventional protector, was a flat frequency response within the range 15 dB-18dB attenuation. Three methods of achieving the required attenuation performance were identified, i.e. passive non-linear, electronic non-linear and active noise reduction. The first two were chosen for further investigation. After laboratory and field trials, four defenders were identified as close to the overall requirements although each would need some degree of further development. The four were the EAR 9000 (passive), an electronic prototype developed during the project, and two commercially-available electronic non-linear devices. 10 refs., 19 figs., 6 tabs.

25388 (PB–90-142332/XAB) **Industrial hygiene assessment of coal-gasification plants.** Cubit, D.A.; Tanita, R.K. Dynamac Corp., Rockville, MD (USA). Mar 1982. 172p. Available from NTIS, PC A08/MF A01.

Worker exposures to hazardous chemicals were evaluated at coal gasification facilities. Industrial hygiene surveys were conducted, and air samples were collected for analysis of polynuclear aromatic hydrocarbons, polynuclear aza heterocyclic hydrocarbons, aromatic amines, metals, common toxic gases, and other organic compounds. Sampling results indicated that workers were exposed to polynuclear aromatic hydrocarbons in the low microgram per cubic meter range, with the light molecular weight compounds in higher concentrations than the four through seven ring compounds. Some specific activities produced higher concentrations. Aromatic amines, phenolic compounds and simple aromatic solvents were occasionally present at very low levels.

25389 (PB–90-142761/XAB) **Engineering health-hazard control technology for coal-gasification and liquefaction processes. Final report.** Dynamac Corp., Rockville, MD (USA). Enviro Control Div. 1983. 120p. Available from NTIS, PC A06/MF A01.

A study was conducted to document hazard control technology options which provide effective protection for the safety and health of workers involved in the conversion of coal to supplement petroleum and natural gas supplies. These workers had the potential of being exposed to toxic materials from leaks and spills from process and waste streams during normal facility operation and during maintenance. Additional hazards of heat and noise, and danger from spontaneous combustion fires and explosions were also noted. The principle hazards discussed in relation to coal conversion included exposure to coal derived liquids, carbonmonoxide, and hydrogen-sulfide. Such liquids were highly aromatic and contained polyaromatic hydrocarbons and aromatic amines associated with carcinogenic and mutagenic effects. Recommendations were offered for engineering controls and for changes in work practices which would reduce potential exposures.

25390 (PB–90-157926/XAB) **Causes of disability in coal miners: A clinico-pathological study of emphysema, airways obstruction, and massive fibrosis. Final report, April 1985-September 1988.** Ruckley, V.A.; Fernie, J.M.; Campbell, S.J.; Cowie, H.A. Institute of Occupational Medicine, Edinburgh (UK). May 1989. 158p. (TM–89/05). Available from NTIS, PC EE08/MF E08.

The report is based on autopsy studies of coalworkers' lungs drawn from a collection of almost 1400 lungs made between 1972 and 1986. Examination of cause of death in the autopsy group, of whom 79% were included in a mortality study based on the Pneumoconiosis Field Research population, showed that the autopsy group included higher proportions of men dying from bronchitis, emphysema and pneumoconiosis than did the parent mortality population. It is concluded that control of dust exposure continues to be an important goal for the containment of both the development of massive fibrosis and the occurrence of emphysema. It is clear also that smoking is a major contributor to respiratory ill-health and should be tackled by appropriate educational measures. Early detection of PMF may be aided by the recognition of opacity clustering on radiographs and monitoring should continue into retirement as increase in lesion size may continue after exposure ceases. In addition, particular vigilance is required in mining environments where quartz exposure is likely to be high as the results suggest that any fibrosis which may develop under such conditions will deserve the title progressive.

25391 (PB–90-161647/XAB) **Statistical analysis of the size and elemental composition of airborne coal-mine dust. Open File Report (Interim) 1984-86.** Mutmansky, J.M.; Lee, C. Pennsylvania State Univ., University Park, PA (USA). Generic Mineral Technology Center for Respirable Dust. Mar 1987. 288p. Available from NTIS, PC A13/MF A02.

The report was part of an ongoing effort at The Pennsylvania State University to investigate the characteristics of airborne mine dusts and its relationship to coal worker's pneumoconiosis (CWP). The specific purpose of the project was to analyze the size and elemental composition of airborne coal mine dusts and the ramifications of these characteristics. A dust sampling strategy using multi-stage cascade impactors was established for characterization purposes. Analysis of the size distributions of the collected samples was performed based upon the aerodynamic diameter of the dust. Patterns of lognormality and bimodality were found in the data. Elemental analysis was performed by the PIXE method for both major and trace elements. Size dependency and locational variation of the elemental composition of the airborne dust were significant in some cases. Relationships to the mining section activities were also investigated.

0170 Legislation and Regulations

25392 (VTT-SYMP–103, pp. 113-128) **Future policy and programmes of the Finnish Ministry of the Environment.** Estlander, A. (Ministry of the Environment, Helsinki (Finland)). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8805445–: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology. Volume II.* Available from Valtion Teknillinen Tutkimuskeskus, Espoo (Finland).

Reviews environmental policy in Finland in the following areas: recycling of wastes; air pollution prevention (especially of sulfur dioxide and nitrogen oxides); and water protection. The cost of implementing these programmes is discussed.

02 PETROLEUM

0202 Reserves, Geology, and Exploration

Refer also to citation(s) 26985, 26986, 26988, 26997, 26998, 27001, 27002, 27003, 27004, 27006, 27007

25393 (DOE/BC–89/6/SP) **Abandonment rates of the known domestic oil resource.** ICF-Lewin Energy, Fairfax, VA (USA). Nov 1989. 39p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86BC14000. Order Number DE89000744. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

After currently proved reserves are produced by conventional methods, nearly two-thirds of the known domestic oil resource — more than 300 billion barrels — could be abandoned in reservoirs in the Lower-48 United States. This resource is not economically recoverable with currently available technologies. Production of any meaningful portion of this oil will require both adequate oil prices and technology advances in such areas as reservoir description and secondary and tertiary recovery. Cost-effective application of such new or improved technologies now depends largely upon the use of existing wells as points of access to the reservoirs containing the remaining oil resource. Existing US wells, however, are being plugged and abandoned at record rates, which impairs economic access to this remaining resource. This study was designed to estimate the amount of known remaining oil resource associated with abandoned wells and to project future abandonments as a function of oil prices. 5 figs., 2 tabs.

25394 (DOE/ER/13182–T1, pp. 445-462) **Petroleum geology of the United States Atlantic continental margin.** Mattick, R.E. (Geological Survey, Reston, VA (USA)); Libby-French, J. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

Early hydrocarbon exploration on the U.S. Atlantic continental margin was concentrated in the shallow water depths of the Continental Shelf over Georges Bank Basin, Baltimore Canyon Trough, and the Southeast Georgia Embayment. In 1983-84, exploration shifted from the shelf area to the slope. During this period, deepwater drilling tested the Jurassic-Cretaceous reef trend beneath the mid-Atlantic Continental Slope. Some areas of the continental margin, such as the Carolina Trough and the Blake Plateau Basin, remain untested. In addition, with the exception of the Tertiary and uppermost part of the Cretaceous section, the thick wedge of sedimentary rocks on the lower slope and upper rise remains to be tested. The purpose of this chapter is to review exploration efforts, summarize the petroleum geology of the U.S. Atlantic margin, and comment on the potential of yet untested or partially tested rock sections of the margin.

25395 (DOE/ER/13182–T2, pp. 65-76) **A synthesis of the Jurassic system in the southern Rocky Mountain region.** Peterson, F. (Geological Survey, Denver, CO (USA)). Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

This chapter includes important stratigraphic revisions and nomenclatural changes made especially in the Colorado Plateau region in recent years. For the purpose of the discussion, these rocks are divided into six divisions. The stratigraphy and depositional environments of the rocks are discussed, along with the economic resources of these rocks which include uranium and hydrocarbons.

25396 (DOE/ER/13182–T2, pp. 77-82) **Cretaceous rocks of the Western Interior basin.** Molenaar, C.M. (Geological Survey, Denver, CO (USA)); Rice, D.D. Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The Cretaceous rocks of the conterminous United States are discussed in this chapter. Depositional facies and lithology are reviewed along with economic resources. The economic resources include coal, hydrocarbons, and uranium.

25397 (DOE/ER/13182–T2, pp. 109-220) **Basins of the Rocky Mountain region.** Bartleson, B.L. (Western State College, Gunnison, CO (USA)); Chapin, C.E.; De Voto, R.H.; Everett, J.R.; Johnson, R.C.; Molenaar, C.M.; Peterson, F.; Schenk, C.J.; Love, J.D.; Merin, I.S. Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

Each of the sedimentary basins of the Rocky Mountain province is geologically unique. All have been structurally controlled by different episodes and styles tectonic activity. At least some of the structures have been reactivated one or more times during Phanerozoic. In this chapter, a generalized view of the tectonics and geologic history of the Rocky Mountain region is given, along case studies of different basins such as the Paradox, San Juan, Henry, Kaiparowits, Black Mesa, Piceance Creek, Unita, Green River, Raton, South Park, and Denver basins. Economic resources are also discussed.

25398 (DOE/ER/13182–T2, pp. 221-241) **Geology of the Williston basin (United States portion).** Gerhard, L.C. (Colorado School of Mines, Golden, CO (USA)); Anderson, S.B. Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The Williston basin is an elliptical shaped depression in the western distal Canadian Shield occupying most of North Dakota, northwestern South Dakota, eastern Montana, and parts of southern Manitoba and Saskatchewan. Williston basin evolution in the Phanerozoic time began with Upper Cambrian transgression across a rough Precambrian topographic surface, but without definition of the basin. During deposition of the Kaskaskia sequence, movement along the Transcontinental Arch tilted the Williston basin northward, creating a marine connection to the north through the Elk Point Basin during Devonian time, while shutting off the earlier Cordilleran and midcontinent marine connection of the Tippecanoe sequence. During deposition of the upper part of the Kaskaskia sequence (Mississippian), the northern connection was cut off and the Williston basin reconnected to the Cordilleran sea through the Central Montana Trough. Pennsylvanian structural disturbance in the Central Rockies disrupted sedimentation patterns of primarily carbonate-dominant lithologies in the basin. A full marine setting was established during the Cretaceous as part of the Western Interior seaway. Regression accompanying uplift of the Laramide Rockies provided faludal and fluvial environments, which trapped much sediment moving eastward from the Rockies during Paleocene time and assissted in the formation of extensive lignite deposits. The basin appears to be the results of drag along two left-lateral shear systems. These shear systems formed a depressed block, which now encompasses the Central Rocky Mountains and the southern Williston Basin. Substantial quantities of lignite, potash, halite, and petroleum are present in the Williston Basin.

25399 (DOE/ER/13182--T2, pp. 261-306) **The Permian basin region.** Bloomer, R.R. (Bloomer and Associates, Abilene, TX (USA)); Cline, R.B.; Gibson, W.R.; Hills, J.M.; King, W.E.; Seager, W.R.; Kottlowski, F.E.; Thompson, S. III; Frenzel, H.N.; Cys, J.M. Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The Permian Basin region, as defined for this chapter, includes all of the Permian basins beneath the high plains of western Texas that lie south of the Red River and Matadoe Uplifts. It also extends westward into the Southern Rocky Mountain region to include the related Orogrande and Pedregosa Basins in New Mexico. In the central part of the region, surface exposures of the Tertiary Ogallala Formation and other post-Paleozoic strata hide the Paleozoic geology, which includes many anticlinal and faulted structures, sand, and shale basins, and carbonate shelf areas. On these shelves, carbonates grade into evaporite deposits and eventually into continental clastics. Knowledge of this geology is primarily from wells drilled for oil and gas. Peripheral outcrops of these Paleozoic strata do exist and are important to the interpretation of Permian Basin geology, but many formations and rock facies are known only from the subsurface.

25400 (DOE/ER/13182--T2, pp. 471-492) **The Black Warrior basin.** Thomas, W.A. (Univ. of Alabama, Tuscaloosa (USA)). Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The Paleozoic Black Warrior foreland basin on the southeastern edge of the North American craton in Alabama and Mississippi is similar to other foreland basins along the Appalachian-Ouachita orogen. The eastern part of the basin is exposed in north-central Alabama, but the western part is covered by Mesozoic-Cenozoic strata of the Gulf Coastal Plain. A regional pre-Mesozoic unconformity truncates Paleozoic strata and dips gently southwestward toward the broad southward-plunging syncline that defines the Mississippi Embayment of the Gulf Coastal Plain. The oldest sedimentary rocks in the basin are of Cambrian age and rest unconformably on Precambrian crystaline basement rocks. The youngest strata of the Paleozoic succession are of Pennsylvanian age, which are unconformably overlain by Cretaceous strata in the western part of the basin and exposed in the eastern part. Structurally, the Black Warrior foreland basin is a nomocline that dips southwestwardly away from craton and extends beneath the front of the Paleozoic Appalachian-Ouchita fold-thrust belt. Coal, natural gas, oil, and coal bed methane are produced from various strata in the Black Warrior basin.

25401 (SAND--89-2894) **Petroleum storage potential of the Chacahoula salt dome, Louisiana.** Magorian, T.R. (Magorian (Thomas R.), Amherst, NY (USA)); Neal, J.T. Sandia National Labs., Albuquerque, NM (USA). Jan 1990. 27p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. Order Number DE90007899. Available from NTIS, PC A03/MF A01 - OSTI.

Chacahoula salt dome, eight miles southwest of Thibodaux, LA, could be solution mined to create caverns for storing as much as 500 million barrels (MMB) of crude oil, should the Strategic Petroleum Reserve (SPR) require additional storage volume. The salt mass geometry is confirmed by more than 50 oil wells, and also from previous exploratory drilling for sulphur. Top of salt occurs at --1100 ft, and some 1300 acres exist within the --2000 ft salt contour. Frasch mining of 1.35 million long tons of sulphur caused the surface to subside about one foot on the northeastern part of the dome. Creep-induced subsidence averaging ~2.7 ft over 30 yrs is estimated for a 200 MMB cavern array, which would require perimeter diking to control localized perennial flooding. Earthquakes approaching intensity MM 6 have occurred nearby and are expected to recur on the order of ~100 yrs but would not affect cavern stability. Additional study of brine disposal methods and hurricane surge probabilities are needed to establish design parameters and cost estimates for storage. 11 refs., 8 figs., 2 tabs.

25402 (UT/BEG--90008973) **Bureau of Economic Geology: Annual report, 1989.** Texas Univ., Austin, TX (USA). Bureau of Economic Geology. 1989. 68p. Sponsored by University of Texas. Available from OSTI; Bureau of Economic Geology, University of Texas at Austin, Austin, TX 78713.

The Bureau of Economic Geology, now celebrating its 80th year as a geoscience research institution, has steadily grown to become one of largest state geological agencies in the United States. This growth is dramatically represented by the numerous projects conducted in 1989, covering a wide range of research topics funded from a variety of sources. By all measures, 1989 was one of the most vigorous and dynamic years in the Bureau's history, with an operating budget of $10 million and a total of 51 ongoing research projects. Of these 51 projects, 11 were initiated in 1989, notably: (1) the State Lands Energy Resource Optimization (SLERO) Center, managed by the Bureau and composed of a consortium of Texas state universities to research development of improved strategies for petroleum recovery from State Lands; (2) the National Gas Atlas, funded by the Gas Research Institute to synthesize data on major gas reservoirs of the central and eastern Gulf Coast and Midcontinent regions of the US; and (3) four reservoir characterization projects that involve study of outcrop and modern-environment, reservoir-scale facies assemblages and their petro-physical properties to help detail the architecture of flow-unit heterogeneities in analogous subsurface petroleum reservoirs. 12 figs.

25403 High-pressure ammonia CI-MS and CI-MS/MS for porphyrin structure determination. Van Berkel, G.J. (Oak Ridge National Lab., TN (USA)); Glish, G.L.; McLuckey, S.A.; Tuinman, A.A. pp. 30 of American Chemical Society, Division of Geochemistry, Inc. 199th ACS national meeting. . American Chemical Society, Washington, DC (US) (1990). DOE Contract AC05-84OR21400. (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

High-pressure ammonia CI-MS of a porphyrin produces a relatively complex spectrum consisting of mono-, di-, and tri-pyrrolic fragment ions. Such CI mass spectra are useful for determining the pyrrole sequence of the porphyrin or for confirming structural assignments based on other data. However, because of the complex ion source chemistry responsible for the production of these fragments, the CI mass spectrum of a porphyrin is often difficult to reproduce and is usually complicated by a plethora of uninformative peaks. In this paper, their work aimed at increasing the analytical utility of CI-MS for porphyrin structure determination will be presented. This work will be discussed in two parts. Presented first will be their study of the mechanisms responsible for porphyrin reduction and decomposition in a high-pressure CI ion source. Second, they will present a CI-MS/MS technique for pyrrole sequencing of porphyrins that is superior to using the CI mass spectrum for this purpose. With this technique, the MS/MS daughter ion spectrum of in situ formed $(M+7H)^+$ (i.e., the protonated porphyrinogen) is used to determine the pyrrole sequence of the porphyrin and the combined mass of the substituents on the individual pyrroles.

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Refer also to citation(s) 25305, 25369, 25432, 25736, 26403, 26404, 26407, 26569, 26570

25404 (AE/SESR--1/093) **Development of a coal-fired boiler for steam injection in heavy oil recovery.** Alberta Energy, Edmonton, AB (Canada). Scientific and Engineering Services and Research Div. 1989. 13p. (MICROLOG--90-01018). Available from PC Alberta Dept. of Energy, Information Centre, 9915 108 St., Edmonton, AB, CAN T5K 2C9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A research program has been under way in Alberta to investigate the use of locally available subbituminous coal as an energy source for steam generation in heavy oil recovery. Results from various parts of this program are described. A coal-fired steam injection boiler was designed to be used with pulverized coals having specific properties. The design includes furnace sorbent injection technology for reducing sulfur dioxide emissions, and dust collection equipment to satisfy NOx and particulate emission guidelines.

Another project investigating NOx and SOx emission control concluded that in-furnace technology should be used as much as possible, and recommended a combination of sorbent injection and multi-stage burners. A low-NOx/SOx burner developed by Rockwell International was tested and found to be very effective. It was also suggested that this type of burner could be retrofitted to existing gas-fired steam generators, as an alternative to constructing new coal-fired boilers. A project was initiated to demonstrate the ability to burn coal in an existing heavy oil recovery steam generator, using the low NOx-SOx burner, located in the Cold Lake area. 4 figs., 1 tab.

25405 (ANL/CNSV-TM–186, pp. 65-99) **Current status of the use of CO_2 for enhanced oil recovery.** Taber, J.J. (New Mexico Petroleum Recovery Research Center, Socorro (USA)). Argonne National Lab., IL (USA). Jun 1988. (CONF-8703302–: Workshop on recovery and use of waste CO_2 in enhanced oil recovery, Denver, CO (USA), 19-20 Mar 1987). In *Recovery and use of waste CO_2 in enhanced oil recovery. Proceedings.* Order Number DE89002803. Available from NTIS, PC A06/MF A01.

Carbon dioxide flooding is probably the fastest growing enhanced oil recovery method in sue today with about 100 projects underway or planned. There are both technical and economic reasons for this steady growth. Large volumes of CO_2 are now available in some areas at high purity and at pressures needed for efficient oil recovery. Existing pipelines are already capable of delivering large quantities of CO_2 to reservoirs which respond well to CO_2 flooding. If pressure requirements are met, the displacement of oil by CO_2 can be efficient, at least in those areas of the oil reservoirs swept by CO_2. Although CO_2 bypasses some oil, and breaks through early at the production wells, oil is produced effectively for a very long period. Fortunately, the produced CO_2 can be separated and recycled efficiently to achieve good ultimate recovery. In general, as CO_2 floods in the Permian Basin of west Texas and eastern New Mexico mature, it appears that the net oil recovery will be even better than predicted. The technology of CO_2 flooding is still evolving, and the economics depend strongly on crude oil prices. The current status of CO_2 flooding is described with reference to specific field results. Information on all of the major CO_2 floods in the United States is given and the projects are located on maps. 55 refs., 17 figs., 8 tabs.

25406 (DOE/BC/10302–T2) **Genetic, physiological and nutritional studies on Clostridium strains isolated and screened for characteristics useful in enhanced oil recovery, with special reference to high salt tolerance: Quarterly progress report for January 1, 1987–March 15, 1987.** Grula, M.M.; Russell, H.H. Oklahoma State Univ., Stillwater, OK (USA). Dept. of Botany and Microbiology. 1987. 25p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AS22-80BC10302. Order Number DE90009053. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Studies on the growth of Clostridium continued. The effects of trace minerals and a vitamin mixture, metal ions, L-proline, glycine betaine, and sodium chloride on growth and gas production were investigated. Also the effect of L-proline, and glycine betaine on sodium chloride inhibition of growth and gas production were investigated. 4 refs., 2 figs., 9 tabs. (CBS)

25407 (DOE/BC/10843–15) **Investigation of the application of gelled polymer systems for permeability modification in petroleum reservoirs: Final report, October 1, 1987–September 30, 1988.** Willhite, G.P.; Green, D.W.; Thiele, J.L.; Young, Teng-Shau; Mertes, K.B. Kansas Univ., Lawrence, KS (USA). Mar 1990. 216p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-85BC10843. Order Number DE90000229. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

This is the Final Report of an integrated research program to improve the performance and predictability of in situ gelation processes that can be used to improve the volumetric sweep efficiency of waterfloods and other enhanced oil recovery processes. Research was divided into three segments: (I) Physical and Chemical Characterization of Gelled Polymer Systems, (II) In situ Gelation and (III) Correlation and Mathematical Modeling of In situ Gelation. Techniques were developed to study the kinetics of the thiourea/Cr(VI) reduction reaction which is used to control the rate that CR(III) is produced in one of the gelation processes. Gelation of polymers under shear was examined using rheological methods. The effect of shear on the gelation of a Cr(III)/polyacrylamide system was determined. In situ gelation of xanthan/Cr(III) was studied in sandpacks and the mechanisms of in situ gelation were identified from interpretation of pressure profiles and effluent concentration data. Effects of shear rate and permeability of the gelation process were determined. The persistence of permeability reduction resulting from in situ gelation of xanthan/Cr(III) in sandpacks was determined experimentally using gels that exhibited swelling and syneresis in bottle tests. In situ gelation of polyacrylamide/Cr(III) was studied in Berea sandstone core material. A mathematical model of the in situ gelation process for Cr(III)/polyacrylamide was developed. 60 refs., 77 figs., 22 tabs.

25408 (DOE/BC/14126–5, pp. 2-6) **Flow properties study: Oil-water relative permeability studies.** Hagedorn, K.D. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

Numerous studied have been conducted to determine the effects of temperature on relative permeability. However, the results of these studies have often been contradictory. A number of researchers have reported an increase in oil relative permeability and a decrease in residual oil saturation with increasing temperature. Mark Miller, however, reported no effect of temperature on relative permeability. Capillary number and wettability changes have been suggested as the reason for these observed changes in relative permeability. The purpose of this study is to further investigate the effects of temperature on relative permeability in an attempt to resolve these inconsistencies. The experiments run in this study were the unsteady-state, or dynamic displacement type. The advantage of this type of experiment is that it is much less time consuming than the steady-state method. The effluent production of both the oil and water phases and the pressure drop across the core are measured, and the relative permeability is calculated using the Johnson, et al. technique. The curve fitting equations currently employed in the calculations are those used by Miller in his work on relative permeability.

25409 (DOE/BC/14126–5, pp. 7-18) **Flow properties study: Comparison of relative permeability curves obtained from unsteady state experiments and calculated from capillary pressure data.** Shimbo, D. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

Measurement of relative permeability from laboratory data has become an increasingly important subject in reservoir engineering as the need has arisen for more accurate forecasting of production flowstreams and ultimate recovery. Engineers now recognize that the shape of the relative permeability curve can be as important as the endpoint saturation. The relative permeability curves from the centrifuge and coreflood differ in both shape and endpoint saturations. Centrifuge curves cover a wider range of saturations and have a tendency to exhibit lower residual wetting phase saturations. Coreflood curves require extrapolation to residual saturation endpoints and measurement error often results from the graphical determination of slope. The objectives of this research are to: (1) devise a generalized coreflood/centrifuge simulation model for determining relative permeability; (2) compare laboratory relative permeability data from the same rock using the Johnson, Bossler, Naumann method for coreflooding and the Hagoort method for centrifuging; and (3) use the simulation model and laboratory data to identify key parameters that differentiate centrifuge relative permeabilities from coreflood relative permeabilities.

25410 (DOE/BC/14126–5, pp. 20-21) **In-situ combustion: Kinetics study.** De los Rios, C.F.; Brigham, W.E.; Castanier, L.M. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

In-situ combustion is a process whose applicability is partly determined by the combustion characteristics of the specific crude oil

in question. These characteristics are directly influenced by the rate of oxidation reactions occurring in the rock matrix ahead of the combustion front. A method is therefore sought by which these characteristics may be altered within a reservoir, thus making the process feasible for a wider variety of crude oils. The presence of catalysts may have a significant influence on the reactions. The effects of catalyzing agents on the kinetics of these reactions were therefore studied to gain a more thorough understanding of the mechanisms involved in the catalysis of crude oil oxidation.

25411 (DOE/BC/14126–5, pp. 22) **In-situ combustion: Tube runs.** Baena, C. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

In order to quantify the changes observed in the previously mentioned kinetics experiments it was decided to initiate a series of combustion tube runs. The experimental program will consist of: a control run (no additive); a run with iron chloride; a run with zinc chloride; a run with tin chloride; and another control run. Experimental problems have delayed the start of this project but the experimental apparatus has been repaired and calibrated and the first control run performed. Completion of this phase of the project is scheduled for March 1988.

25412 (DOE/BC/14126–5, pp. 23-35) **In-situ combustion: Analytical model of CO_2-steam-heavy oil displacements using method of characteristics.** Wingard, J. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

The model uses the method of characteristics to solve a simplified flow of an arbitrary number of components that partition into an arbitrary number of phases. The model is similar to that developed by Dumore with the addition that the system has a temperature variation along the direction of flow. The major assumptions of the model are: the flow is one-dimensional; all mass and energy transport is by convection; and there is instantaneous chemical and thermal equilibrium. The model is described and analytical derivatives and temperature shock calculations are explained. Programming and results for the two-phase, constant temperature system are discussed.

25413 (DOE/BC/14126–5, pp. 37-39) **Steam with additives: Transient behavior of foam flow in 1-D porous medium.** Liu, D. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

This work is a continuation of Erickson's work on the transient behavior of foam flow in a one-dimensional porous medium. The equipment used is a modified version of that used by Treinen et al. Most studies have dealt with steady state foam injection, but true steady state conditions are rarely achieved for a field project. Few experimental data are available for transient foam flow. The ultimate goal of this work is to develop a predictive model for foam flow in porous media. The first step in creating such a model is to accumulate basic experimental data on transient foam flow. The system studied is a one-dimensional, low temperature, low pressure environment. Experimental procedure is described and results to date are given and discussed.

25414 (DOE/BC/14126–5, pp. 40-55) **Steam with additives: Steam foam 1-D model.** Maneffa, M. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

The foam diverting capabilities of the surfactant Chaser SD1000 were measured in a linear sandpack at steam conditions. The effects of nitrogen and surfactant concentration were investigated. Ottawa sand, 170 to 200 mesh, was packed into a 6 ft stainless steel tube. In the two sandpacks used, the porosities ranged from 35.3 to 36.2 % and the permeabilities ranged from 5 to 6.2 days. The sandpacks were originally saturated with water and then flooded with oil to residual water saturation. Afterwards, the sandpack was steamed to residual oil saturation to represent a steam channel. Results showed that the SD1000 slugs at concentrations from 0.1 wt % to 1.0 wt % performed no better than slugs of water. This was observed whether or not nitrogen was injected. For the runs with nitrogen, it was also observed that the largest pressure gradient increases were in the last 20 in. of the sandpack, and the second SD1000 slug performed slightly better than all other slugs. Conclusions to data are discussed.

25415 (DOE/BC/14126–5, pp. 56) **Steam with additives: Foamers and emulsifiers.** Farrell, J. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

The aim of this research was to investigate the gas mobility reducing effects that a gas driven surfactant slug has on enhanced oil recovery (EOR). Three chemically similar surfactants whose properties graded from foaming agent to emulsifying agent were used to study the relative effects that foam and emulsion formation have on gravity override and enhanced oil recovery in an unconsolidated Ottawa sand model at room temperature. Both the foam lamellae and the emulsion droplets can act to reduce the mobility of the injected gas in the swept zone thus increasing the vertical sweep efficiency. Shell's Enordet series of alcohol ethoxylate surfactants were used in the study at three different concentrations of 0.01%, 0.03% and 0.10%. The experimental procedure consisted of displacing oil from a two-dimensional (x, z slice) porous medium at residual water saturation by injecting carbon dioxide, followed first by the injection of a 0.20 pore volume slug of surfactant solution, then by carbon dioxide gas at low pressure. At these low pressures, carbon dioxide acts as an inert gas. Measurements were made of the cumulative produced gas and liquids. The main conclusion to be drawn from this study is that combining the foam and emulsion mechanisms may lead to more efficient oil recovery than either mechanism alone. Also the differences between the surfactants are small but consistent.

25416 (DOE/BC/14126–5, pp. 57-62) **Steam with additives: One-dimensional steam flood experiments.** Shallcross, D. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

The existing one-dimensional sandpack was used to continue the steam flooding experiments of Wang and Maneffa. Steam and nitrogen were simultaneously injected into the sandpack that contained oil at a residual saturation. Aqueous slugs of either water or surfactant solutions were then injected while the pressure gradient along the tube was monitored. An increase in the gradient would indicate the formation of foam. Before equipment failure delayed the experimental program, three surfactants were tested: Chevron Chaser SD1000, Dowfax and Shell Enordet LTS18. Experimental procedure, results, and future work are described.

25417 (DOE/BC/14126–5, pp. 64-68) **Reservoir Evaluation: Flow through perforations.** Ahmed, G. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

A good perforation design can increase the productivity of a well beyond that of an open wellbore. It can create the effect of a larger wellbore diameter without the additional costs of drilling, casing and completions. Considering the number of physical parameters and the costs, extensive sensitivity analysis is needed for an optimum perforation design. For the currently used simulation models, extensive sensitivity analysis would be expensive and unwieldy, not to mention the worry about accuracy. An analytical closed form solution will provide an insight into the optimization problem, and, hopefully, reduce the computational effort required. Three approaches, namely, conformal mapping, matches asymptotic expansions and Green's function were considered for developing an analytical closed form solution to the steady state single phase

flow problem. After extensive effort it was found that the first two approaches did not appear feasible and thus the solution has been synthesized using Green's functions. The following briefly discusses all these approaches.

25418 (DOE/BC/14126–5, pp. 69-76) **Reservoir evaluation: Single well tracer studies.** Riley, M. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

The purpose of the present research is to simplify already existing solutions to the radial Convection-Dispersion (C-D) equation. These solutions are quite complex, even in Laplace space. The real space inversion of these solutions are usually in the form of the sum of three definite integrals. These integrals involve Bessel Functions of one-third order, or equivalently, Airy Functions. Because these integrals are so complicated, they are difficult to evaluate, but more importantly they give no clue as to the nature of the solution. The motivation for this research comes from the work of Falade, who solved the single well tracer testing problem in radial coordinates. His problem consisted of solving eight partial differential equations. Two each for the injection, displacement, reaction and back production phases. The reason that he had to solve two equations for each phase is that the primary tracer undergoes an irreversible reaction that produces a secondary tracer. In the present phase of research the authors are attempting to solve the entire radial tracer testing problem. The hope is that they will be able to find very accurate approximate solutions to the radial C-D equations, i.e. only the first phase of the full problem. This should give them insight into the nature of the solution and should enable them to find good approximate solutions to the more complicated problems.

25419 (DOE/BC/14126–5, pp. 77) **Reservoir evaluation: Thermal recovery well test design and interpretation.** Ambastha, A. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

Because a reservoir undergoing a thermal recovery process is typically idealized as a composite reservoir, this study develops new design and interpretation equations by investigating pressure derivative behavior of a well in two-zone, radial, infinite or finite composite reservoir. Accurate design equations help estimate the test duration required to observe a particular feature in well test data and thus, establish the applicability of an interpretation method to determine front radius, or swept volume. This study shows that the dimensionless time to the end of first semi-log line (deviation time) based on front radius is a constant. The deviation time method may be used if wellbore storage does not mask the first semi-log line. Inner boundary effects on the applicability of the first semi-log line, and the end of wellbore storage effects. This method is sensitive to deviation time, and may underestimate swept volume significantly in the case of an irregular swept region. Design equations for the time to the beginning of the second semi-log line, and the time to feel outer boundary effects show that the intersection time method is not suitable for thermal recovery well test analysis. Correlations developed for the end of pseudosteady state behavior of the swept region should help choose the correct Cartesian line to calculate swept volume. The design equations for the time to maximum semi-log slope, and the magnitude of the maximum derivative are developed. This paper also presents new derivative type-curves applicable for all front radii, with mobility and storativity ratios as parameters for infinitely large composite reservoirs.

25420 (DOE/BC/14126–5, pp. 78) **Reservoir evaluation: Prediction and interpretation of miscible displacement performance using a transverse matrix diffusion model.** Correa, A.C.; Pande, K.K.; Ramey, H.J. Jr.; Brigham, W.E. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

This paper considers interpretation of effluent flowing concentration data obtained from heterogeneous cores using the following heterogeneous models: Coats-Smith, porous sphere, and transverse matrix diffusion. Analytical solutions to the three heterogeneous models are presented in Laplace space. Approximate solutions for short and long time effluent flowing concentrations are developed from simplification of the Laplace transformation solution. These approximations are used to develop practical methods of interpretation of effluent concentration data to determine model parameters. Criteria for design of laboratory experiments are suggested on these results. Currently the heterogeneous model equations are usually solved by finite difference methods which result in inherent numerical dispersion in addition to the actual physical dispersion. Thus, the computed dispersion coefficient must be corrected for numerical dispersion. In this paper the solutions to the model equations are obtained by numerically inverting the Laplace transformed solutions using an efficient algorithm. This solution method is computationally advantageous to the conventional finite difference approximation. Results obtained from displacements in laboratory experiments only reflect the scales of heterogeneity present in the laboratory core. However, the scales of heterogeneity may be much larger in the reservoir. This paper discusses computation of miscible displacement performance based on a model which considers the interaction of heterogeneities present in the reservoir with mixing mechanisms.

25421 (DOE/BC/14126–5, pp. 79) **Reservoir evaluation: Analysis of pressure and tracer test data for characterization of areally heterogeneous reservoirs.** Mishra, S.; Brigham, W.E.; Orr, F.M. Jr. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

This study compares simulated well-to-well tracer tests and transient pressure tests in a quadrant of a repeated 5-spot with spatial variations in permeability. The computations were performed in order to examine (a) the sensitivity of test responses to the presence of heterogeneity; and (b) the quantification of permeability variation from the analysis of test data. Single-layer heterogeneous media with an autocorrelated and log-normal permeability distribution were generated using a stochastic moving average method. Finite-difference simulation or pressure behavior in these systems indicates that the geometric mean of effective permeabilities around the injection and production wells is a good approximation for the steadystate interwell permeability. A dimensionless permeability difference defined in terms of these quantities was found to correlate with a heterogeneity index, defined as the product of permeability variance and a dimensionless correlation length scale. Tracer flow simulations with a method of characteristics procedure show that when heterogeneity index is small, tracer response can be matched with solutions of the convection-dispersion equation using a constant dispersivity proportional to the heterogeneity index. For larger values of heterogeneity index preferential flow paths are created, which cause tracer breakthrough curves to behave as if they were the result of flow in a layered system. A method is proposed to estimate the heterogeneity index from pressure test data, and thus to predict qualitatively the nature of the tracer response.

25422 (DOE/BC/14126–5, pp. 81-87) **Field support services: Optimization of cyclic steam injection.** Barua, J. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

This is an interim report on a project to optimize cyclic steam injection operations. A simplified mathematical model is used together with optimization algorithms to determine optimum steam injection time, soak time and production time. Preliminary results show that a great improvement in operating economics may be possible if changes are made in current operating practices. To maximize production in the specific case of cyclic steam injection, two major changes appear to be necessary. First, steam soak should be avoided, if necessary by using mechanical means to prevent steam backflow. Secondly, injection times should be greatly increased, a minimum seems to be doubling of current injection times (i.e. doubling of steam volume). Also, while the authors have not shown this to be the case, by common sense it is undesirable

to let the well produce tiny amounts of oil towards the tail end of a production period. It is better to cut if short and start a fresh cycle.

25423 (DOE/BC/14126–5, pp. 88) **Field support services: Thermal simulation.** Gajdica, R. Stanford Univ., CA (USA). Petroleum Research Inst. Nov 1988. (SUPRI-TR–64). In *SUPRI heavy oil research program. Eleventh annual report, October 1, 1986-September 30, 1987.* Order Number DE89000703. Available from NTIS, PC A05/MF A01.

A research effort was recently started in the area of thermal simulation. A more defined topic has not yet been chosen. The Computer Modeling Group (CMG) thermal simulator will be installed on the author's machine in the near future, so he will have local access to a thermal model. He plans to model typical heavy oil reservoirs. The simulator will be run in hopes of determining the relative effects of the known recovery mechanisms (steam distillation, viscosity reduction, gravity drainage, thermal expansion, wettability changes, and oil/water interfacial tension). Based on the results, the mechanisms may be modified or new ones may be defined. Possible results of this work are (1) a set of type curves that could be used instead of a thermal simulator, and (2) a new model for predicting steamflood recovery. The author is currently reviewing the technical literature to obtain a better understanding of what has been done and what could be done. Field data has been gathered and is being evaluated to define the system for initial simulator runs.

25424 (DOE/BC/14204–5) **Cyclic CO_2 injection for light oil recovery: Performance of a cost shared field test in Louisiana: Fifth quarterly report, November 22, 1989–February 21, 1990.** Bassiouni, Z.A.; Groves, F.R. Jr.; Wolcott, J.M. Louisiana State Univ., Baton Rouge, LA (USA). Dept. of Petroleum Engineering. 1990. 9p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-89BC14204. Order Number DE90009146. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The ultimate objective of this research is to provide a base of knowledge on the CO_2 huff 'n' puff process for the enhanced recovery of Louisiana crude oil. Project goals include laboratory corefloods to investigate several parameters important to the process, and numerical simulation to interpret coreflood results. Additional activities include construction and analysis of a field test data base to facilitate target reservoir screening, and to identify sensitive operational parameters. The information from laboratory corefloods and data base evaluations will be used in the design and implementation of a Department of Energy sponsored field test. The results of all laboratory and field evaluations will be made available to the industry through workshops, periodic reports, and meetings. 2 tabs.

25425 (DOE/ER/13182–T1, pp. 529-548) **Geologic hazards on the Atlantic continental margin.** Folger, D.W. (Geological Survey, Woods Hole, MA (USA)). Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

Geologic and hydrologic hazards to exploitation of the U.S. Atlantic Continental Margin vary; the most severe conditions are found on Georges Bank followed by the Carolina Trough and Blake Plateau, and the least severe conditions in the Baltimore Canyon Trough area. Problems on Georges Bank are mainly associated with the winter storms and high tidal current speeds that continuously move small and large sand waves and, mainly during major storms, resuspend abundant fine-textured detritus in sufficient concentrations to scavenge pollutants from the water column. Except for the passage of hurricanes and severe winter storms, which resuspend abundant fine detritus from the bottom, the continental shelf in the Baltimore Canyon Trough area contains few major hazards. Some slumping on the continental slope takes place, probably occurring mainly in canyon heads and walls. In the Southeast Georgia Embayment, the most hazardous areas are in the deep waters of the Carolina Trough and Blake Plateau Basin. Gulf Stream flow and its associated eddies will impose severe stress on any structures or moored facilities, particularly in view of the known phosphate- or manganese-armored hard bottom that will make mooring or burial difficult. In addition, the substrate in some areas may be unstable because of the cavernous porosity immediately below the bottom that developed during several stages of the Tertiary when sea level was low.

25426 (LBL–28340) **Flow and displacement of Bingham non-Newtonian fluids in porous media.** Wu, Y.S.; Pruess, K.; Witherspoon, P.A. Lawrence Berkeley Lab., CA (USA). Jan 1990. 27p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-9004156–1: 1990 SPE California regional meeting, Ventura, CA (USA), 4-6 Apr 1990). Order Number DE90009060. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

There is considerable evidence that the flow of heavy oil in some reservoirs is non-Newtonian and that this behavior can be approximated by a Bingham type fluid. Investigations in the Laboratory and in a few field tests have shown a behavior that is characteristic of a Bingham fluid; the flow of the heavy oil takes place only after the applied pressure gradient exceeds a certain minimum value. At present, there is no reliable method of analyzing pressure buildup data from well tests where the reservoir contains a Bingham oil. This work presents a theoretical study of the flow and displacement of a Bingham type fluid in porous media. An integral method of analyzing the single phase flow of this type of fluid has been developed. An approximate analytical solution has been obtained for transient flow problems, and its accuracy is confirmed by comparison with numerical solutions. The flow behavior of a slightly-compressible Bingham fluid is discussed, and a new method of well test analysis has been developed by using the integral solution. To obtain some understanding of the physics of immiscible displacement with Bingham fluids, a Buckley-Leverett type analytical solution with a practical graphic evaluation method has been developed and applied to the problem of displacing a Bingham-type fluid by water. 34 refs., 15 figs.

25427 (PB–90-142191/XAB) **Production record by platform. Statistical report.** Searls, A. Minerals Management Service, Los Angeles, CA (USA). Pacific OCS Region. 1988. 75p. (OCS/MMS–89/0059). Available from NTIS, PC A04/MF A01.

The report is the first edition of Minerals Management Service, Pacific OCS Region, Production Record by Platform. The report is a compilation of information from the Outer Continental Shelf Information System (OCSIS) and is non-proprietary. The edition includes production through December 1988, and will be updated annually. Development drilling in the Pacific Outer Continental Shelf Region (POCSR) commenced in 1968 with the spudding of Lease OCS-P 0166 Well A-2 from Platform Hogan. Since that time there have been 677 development wells drilled. There are 21 existing platforms in the POCSR, of these 17 are producing, 3 are anticipating production in 1989 (Harvest, Hermosa, and Hidalgo), and 1 (Elly) is for processing. The 17 producing platforms are developing 9 fields in the POCSR. From 1968 through 1988 there has been 431 MMBBLS of oil and 427 BCF of gas produced. Platform production records are listed numerically by lease number for easy reference. Production of oil, gas, and water is presented on a monthly and daily basis.

25428 Modeling pressure transient behavior of sectionally heterogenous reservoirs by the boundary element method. Kikani, J. (Stanford Univ., CA (USA)); Horne, R.N. pp. 870 of Proceedings of the 1989 SPE annual technical conference and exhibition: Reservoir engineering. . Society of Petroleum Engineers, Richardson, TX (USA) (1989). (CONF-891049–: Society of Petroleum Engineers annual technical conference and exhibition, San Antonio, TX (USA), 8-11 Oct 1989).

SPE 19778.

Heterogeneities in petroleum reservoirs complicate pressure transient testing. Conventional analytic techniques can only be used for fairly simple geometries. More complex situations usually require numerical simulation. This paper demonstrates a new approach using the boundary element method (BEM) to solve for pressure transient behavior in complex reservoirs. A Laplace space boundary element solution is proposed to determine the pressure solution in a piecewise homogeneous reservoir with arbitrary geometry of each region. Both pressure and pressure derivative behavior for the systems is presented. Example solutions are verified against known analytical solutions.

0204 Processing

Refer also to citation(s) 25291

0206 Health and Safety

25429 (PB–90-133042/XAB) **Hazard evaluation and technical assistance report HETA 88-010-l1982, Neville Chemical Company, Anaheim, California.** Daniels, W.; Wilcox, T.; Gunter, B. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Jun 1988. 18p. (HETA–88-010-L1982). Available from NTIS, PC A03/MF A01.

The National Institute for Occupational Safety and Health (NIOSH) conducted an evaluation of possible hazardous working conditions at the Neville Chemical Company, Anaheim, California. Concern had been expressed about a carbon resin manufacturing process and two cases of liver disease in workers. The company manufactured petroleum resins by polymerizing organic molecules 5 to 12 carbon atoms in size using both a catalytic and a thermal polymerization process. Raw materials consist of cracked petroleum fractions, containing a wide variety of aliphatic and aromatic-hydrocarbons. Most of the data gathered concerning the health of the workers indicated they were in good physical condition and that the causes of those deaths which had been reported had been misrepresented. Three major areas of concern did arise on inspection of the current working conditions. First was a need for an improved method to be used in the periodic cleaning of the clay filter towers. Secondly, there was excessive exposure to boron-trifluoride in the treater facility. The third problem involved resin dust exposures working as a packager in the warehouse, particularly when the ventilation system was not functioning properly. Even though the dust levels in the area were below the limits for a nuisance dust, it was not clear whether the resin dusts would constitute a hazard.

25430 (PB–90-160326/XAB) **National Oil and Hazardous Substances Pollution Contingency Plan (as published in the Federal Register, March 8, 1990).** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 1990. 577p. Available from NTIS, PC A25/MF A04.

The NCP is the major framework regulation for the Federal hazardous substance response program. The NCP includes procedures and standards for how EPA, other Federal agencies, states and private parties respond under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) to releases of hazardous substances and under the Clean Water Act to discharges of oil. These revisions clarify the 1985 NCP language, reorganize the 1985 NCP to describe more accurately the sequence of response actions, and incorporate changes based on program experience since the 1985 revisions to the NCP.

0207 Economic, Industrial, and Business Aspects

Refer also to citation(s) 25393, 25880, 25925, 26002

25431 (AD-A–216036/4/XAB) **Simplify the Defense Energy Information System. Final report.** Smith, B.A.; Salthouse, R.W. Logistics Management Inst., Bethesda, MD (USA). Jul 1989. 28p. (LMI-PL–908R1). Available from NTIS, PC A03/MF A01.

DOD's current system for keeping track of petroleum fuel use - the Defense Energy Information System, Part I (DEIS-I) - is burdened by untimely reporting of data from the Services. DEIS-I data requirements were originally formulated to identify and monitor petroleum shortages caused by the OPEC embargo of the United States in 1973. At that time, the Executive Branch and Congress had little information to manage this crisis. ODS does not now need or use petroleum data at the level of detail provided by DEIS-I when there is no petroleum crisis. We find that, even in the event of another embargo or energy crisis, sufficient data are available from other sources to meet OSD, Executive Branch, and congressional needs. The Defense Fuel Automated Management System (DFAMS) provides data on bulk petroleum fuel issued to the Services by the Defense Fuel Supply Center (DFSC). DFAMS accounts for 97% of the Services' final consumption as reported by DEIS-I. DFSC also maintains supplemental data on local deliveries to the Services that can augment DFAMS data. DFAMS data are sufficiently detailed to provide the information needed by OSD for all anticipated energy emergencies. We recommended that OSD's Energy Policy Directorate simplify the current DEIS-I system and use data from DFSC. DFSC personnel should provide petroleum data from DFAMS and supplemental sources to OSD's Energy Policy Directorate. A simplified system will make DEIS-I easier to use and will save DoD approximately $76,000 in direct annual costs. Wholesale/retail petroleum data.

25432 (ANL/CNSV-TM–186, pp. 59-64) **Potential need for man-made CO_2 for enhanced oil recovery.** Shepard, T.H. (Production Operators, Inc., Houston, TX (USA)). Argonne National Lab., IL (USA). Jun 1988. (CONF-8703302–: Workshop on recovery and use of waste CO_2 in enhanced oil recovery, Denver, CO (USA), 19-20 Mar 1987). In *Recovery and use of waste CO_2 in enhanced oil recovery. Proceedings.* Order Number DE89002803. Available from NTIS, PC A06/MF A01.

The injection of carbon dioxide into oil reservoirs for enhanced oil recovery has received considerable attention by the industry for several years. Great expectations have existed for some time on the potential of CO_2 as a tertiary recovery injection fluid. The major pipelines of West Texas – Cortez, Sheep Mountain and Bravo Dome – are examples of actions taken in response to these expectations. Many of the past decisions and large capital investments were made in an environment of high and rising oil prices. With the collapse and subsequent instability of world oil prices, it is important to consider the following questions: 1. Can CO_2 flooding exist in the current environment? 2. What is the future for CO_2 flooding? 3. What is the need for additional sources of CO_2? This paper strives to examine and address these questions.

25433 (ANL/ESD–4) **An economic assessment of the impact of two crude oil price scenarios on households.** Poyer, D.A.; Teotia, A.P.S.; Hemphill, R.C.; Hill, L.G.; Marinelli, J.L.; Rose, K.J.; Santini, D.J. Argonne National Lab., IL (USA). Feb 1990. 64p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-31109-ENG-38. Order Number DE90007896. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The impact of two possible future crude oil price scenarios – high and low price cases – is assessed for three population groups: majority (non-Hispanic and nonblack), black, and Hispanic. The two price scenarios were taken from the "energy security" report published by the US Department of Energy in 1987. Effects of the two crude oil price scenarios for the 1986–95 period are measured for energy demand and composition and for share of income spent on energy by the three population groups at both the national and census-region levels. The effects on blacks are marginally more adverse than on majority householders, while effects on Hispanics are about the same as those on the majority. Little change is seen in percentage of income spent on energy over the forecast period. Both Hispanic and black households would spend a larger share of their incomes on energy than would majority households. The relatively adverse effects in the higher price scenario shift from the South and West Census regions to the Northeast and Midwest. 24 refs., 7 figs., 22 tabs.

25434 (CAEC–90008848) **California Energy Commission quarterly oil report: Second quarter 1989.** California Energy Resources Conservation and Development Commission, Sacramento, CA (USA). Dec 1989. 55p. Sponsored by California Energy Commission. (P–300-89-021). Available from OSTI; CEC, Publications Unit, 1516 Ninth Street-MS13, Sacramento, CA 95814.

In this issue, the state of California's petroleum fuels market activity, price trends, refinery activities, production, and petroleum company financial statements are discussed. 10 figs., 6 tabs.

25435 (DOE/EIA–0109(90/01)) **Petroleum supply monthly, January 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 27 Mar 1990. 127p. Sponsored by U.S. DOE Management & Administration. Order Number DE90009168. Available from NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.

Data presented in this report describe the supply and disposition of petroleum products in the United States and major US geographic regions. The data series describe production, imports and

exports, inter-Petroleum Administration for Defense (PAD) District movements, and inventories by the primary suppliers of petroleum products in the United States (50 States and the District of Columbia). The reporting universe includes those petroleum sectors in "Primary Supply." Included are: petroleum refiners, motor gasoline blenders, operators of natural gas processing plants and fractionators, inter-PAD transporters, importers, and major inventory holders of petroleum products and crude oil. When aggregated, the data reported by these sectors approximately represent the consumption of petroleum products in the United States. 18 figs., 46 tabs.

25436 (DOE/FE–0168P) **Doing business with DOE's Fossil Energy Office: A guide for the oil and gas industry.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of the Deputy Assistant Secretary for Oil, Gas, Shale and Special Technologies. Mar 1990. 26p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90007961. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This guide has been prepared to assist those in the oil and gas industry who may not be totally familiar with how the federal government, particularly the US Department of Energy (DOE), does business with private sector companies. Basic information is provided on what DOE is trying to do, why it wants to work with the oil and gas industry, how it can work with companies, and who to contact and where to write for further information. This last item is noteworthy because it is important for users of this guide to be able to get the details about subjects that may interest them. The guide provides an address and/or phone number for every topic covered to prevent informational "deadends". If a question is not adequately answered by the guide, please do not hesitate to contact the appropriate person or office.

0208 Waste Management

Refer also to citation(s) 26020

25437 (CPS–CCME-TS/WM-TRE006E) **Code of practice for used oil management in Canada.** Environment Canada, Ottawa, ON (Canada). Conservation and Protection. Aug 1989. 63p. (MICROLOG–90-00455). Available from PC National Climatological Information Services, CCAS/I, 4905 Dufferin Street, Downsview, ON, CAN M3H 5T4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This code of practice describes environmentally sound options for the handling, storage, collection, transportation, recycling, reuse and disposal of used oils in Canada. Used oil, as referred to in this code of practice, is a lubricating oil which has become unsuitable for its original purpose due to the presence of impurities or to the loss of its original properties. Used oil may or may not be designated as a hazardous waste, depending on the types and amounts of chemical impurities that it contains. The report discusses federal and provincial regulations, the characteristics of used oils, their collection, tranportation, handling and their recycling, reuse and disposal(re-processing, refining, road oiling, asphalt production and other end uses, burning, incineration and landfilling). The dangers of landfarming, sewer disposal and indiscriminate dumping are underlined. Guidelines are provided for the development of used oil management strategies; the disposal of used oils should be discouraged in favor of recycling and controlled buring. 22 refs., 2 figs., 20 tabs.

25438 (CPS–CCME-TS/WM-TRE006F) **Code of practice for used oil management in Canada.** Environment Canada, Ottawa, ON (Canada). Conservation and Protection. Aug 1989. 63p. (MICROLOG–89-06065). Available from PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

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0209 Environmental Aspects

Refer also to citation(s) 25315

25439 (DOE/EA–0401) **Strategic Petroleum Reserve sulphur mines decommissioning and Big Hill expansion, Calcasieu Parish, Louisiana, and Jefferson County, Texas.** . USDOE, Washington, DC (USA). Jan 1990. 56p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90008675. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Department of Energy (DOE) has prepared an environmental assessment (EA), for decommissioning the Strategic Petroleum Reserve (SPR) Sulphur Mines facility and replacing its crude oil storage capacity by expanding the storage capacity at the SPR Big Hill and SPR Bayou Choctaw facilities. Based on the analyses in the EA, DOE has determined that the proposed action is not a major Federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act (NEPA). Therefore, the preparation of an environmental impact statement (EIS) is not required and the Department is issuing this Finding of No Significant Impact (FONSI). 16 refs., 3 figs., 5 tabs.

25440 (PB–90-146374/XAB) **Burning, smoke production, and smoke dispersion from oil-spill combustion.** Evans, D.; Mulholland, G.; Gross, D.; Baum, H.; Walton, W. National Inst. of Standards and Technology (NEL), Gaithersburg, MD (USA). Center for Fire Research. Oct 1989. 58p. (NISTIR–89/4091). Available from NTIS, PC A04/MF A01.

Also available from Supt. of Docs.

The combustion of crude oil layers floated on water were studied to assess the potential of using combustion to mitigate oil spills. Burning rates for n-decane, toluene and Alberta Sweet crude oil were measured in a 1.2 m diameter pool. These were used to estimate the energy transfer rate required to vaporize the fuel as part of an energy balance at the liquid surface. Smoke emission per unit of fuel consumed was dramatically reduced in the case of burning oil layers thin enough to cause boiling in the supporting water layer. A new aging/dilution facility is described that allows for measurement of optical properties and sedimentation velocities as the smoke ages. These characteristics are important in estimating smoke properties downwind of the oil spill fire. A formulation is presented that will provide for estimates of downwind particulate deposition of the fire smoke for a steadily burning oil spill.

25441 (PB–90-148909/XAB) **Oil-Spill Risk-Assessment Task Force report. Final report.** Florida Office of the Governor, Tallahassee, FL (USA). Environmental Affairs. Oct 1989. 228p. Available from NTIS, PC A11/MF A02.

The Oil Spill Risk Assessment Task Force was asked to analyze all potential impacts of exploratory drilling operations on south Florida coastal and marine resources. The report deals with information on the likelihood of an oil spill occurring during exploration activities; existing and planned physical oceanographic information necessary to understand the major current regimes in the south Florida area; the Department of the Interior Oil Spill Risk Analysis Model and other oil-spill probability models; and measures available to mitigate oil-spill risks.

25442 (PB–90-151804/XAB) **Prevention of oil pollution from ships owned or operated by the Department of Defense. Directive.** Higgins, B. Assistant Secretary of Defense (Production and Logistics), Washington, DC (USA). 14 Jun 1985. 21p. (DOD-D–6050.15). Available from NTIS, PC A03/MF A01.

See also PB–83-225300.

The Directive implements the provisions of Title 33, United States Code, Section 1902(d) that require the heads of Federal departments and agencies to prescribe standards for the prevention of pollution from ships for which they are responsible.

25443 (PB–90-157389/XAB) **Oil and hazardous-substances pollution prevention and contingency program. Directive.** Higgins, B. Assistant Secretary of Defense (Production and Logistics), Washington, DC (USA). 1 Jun 1977. 10p. (DOD-D–5030.41). Available from NTIS, PC A02/MF A01.

The Directive reissues DoD Directive 5030.41, October 3, 1972, to reflect revisions to the National Oil and Hazardous Substances Pollution Contingency Plan; implement the Environmental Protection Agency (EPA) Regulations on Oil Pollution Prevention; and to establish a Department of Defense Oil and Hazardous Substances Pollution Prevention and Contingency Program.

25444 (PB–90-157835/XAB) **Superfund Record of Decision (EPA Region 5): Adrian Municipal Well Field, MN. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. Sep 1989. 38p. (EPA/ROD/R–05-89/104). Available from NTIS, PC A03/MF A01.

Portions of this document are not fully legible.

The Adrian Municipal Well Field site is in Adrian, Nobles County, Minnesota, a city which relies solely on ground water for its municipal water supply. In 1983 the State detected VOC contamination in two of the six wells at the site, and by 1985 the city had replaced the VOC-contaminated wells with two new wells. Subsequent ground water sampling indicated that petroleum releases from underground storage tanks (UST) are sources for soil and ground water contamination. Although ground water contaminant concentrations exceed Federal and State drinking water and surface water standards, no further action will be taken by the Superfund program because the program does not have the authority to address clean up of petroleum releases. EPA will, however, formally transfer the site to its UST program in October 1989 for further action. There are no costs associated with this remedial action.

25445 (PB–90-859281/XAB) **Oil spill recovery: Oil booms and skimmers. September 1971-June 1989 (A Bibliography from the US Patent data base). Report for September 1971-June 1989.** . National Technical Information Service, Springfield, VA (USA). Feb 1990. 58p. Available from NTISPC N01/MF N01.

Supersedes PB–88-870258.

This bibliography contains citations of selected patents concerning booms, skimmers, and skimming techniques for oil spill recovery. Selected patents include oil absorbent materials, dispersants, floating booms, methods and equipment for oil spill containment and collection, marine barriers, cryogenic beach cleaners, microbial materials, and ultrasonic oil removal. Citations concerning oil-water separation for non-oil spill recovery applications are excluded and examined in a separate bibliography. (This updated bibliography contains 138 citations, 11 of which are new entries to the previous edition.)

25446 (PEI/E–90-01699) **Investigation into methods and costs for disposal of removed underground petroleum storage tanks and associated contents.** Johnston, D.A.; Jardine, D.E. Prince Edward Island Dept. of the Environment, Charlottetown, PE (Canada). 26 Jun 1989. 71p. (MICROLOG–90-01699). Available from PC Island Information Service, PO Box 2000, Charlottetown, PE, CAN C1A 7N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Disposal options and costs are examined for removed steel underground petroleum tank systems and associated sludges in both Canada and the U.S. Regulatory agencies in Canada and 13 states were contacted for information on disposal methods currently practiced and regulations specifically governing tank disposal. Information for this report was derived from 200 responses to questionnaires on all aspects of tank removals forwarded by mail to known installers and removers of underground petroleum storage tank systems in Canada. Areas identified as needing further research included installations of fiberglass piping in cold weather, the internal deterioration of steel tanks, tank tightness testing procedures, the monitiroing of cathodically protected tanks and secondary containment systems. Options for disposal include scrap (recycling), landfilling, refurbishing and reuse. Disposal options for sludges listed are enhanced landfarming, incineration, and storage in waste oil pits. It is recommended that contractors who remove underground tanks be licensed or registered to improve the overall performance 32 refs., 3 figs., 7 tabs.

0210 Legislation and Regulations

Refer also to citation(s) 25430, 25446

0220 Transport, Handling, and Storage

Refer also to citation(s) 25439

25447 (AD-A–216015/8/XAB) **Fuel-elastomer compatibility studies - results of 80 C/14-day exposure experiments. Interim report, November 1988-July 1989.** Fodor, G.E. Southwest Research Inst., San Antonio, TX (USA). Belvoir Fuels and Lubricants Research Facility. Jul 1989. 32p. (BFLRF–231). Available from NTIS, PC A03/MF A01.

Five collapsible, elastomer-coated fabric products were exposed to four middle distillate fuels and to a middle-distillate fuel simulant. The coated fabrics were represented by a drum material, a pillow tank fabric and its seam section, and a berm liner with its seam section. Each of these samples was treated as individual materials. Compatibility of these products was studied under accelerated conditions, during which each elastomer was submerged in each fuel for 14 days at 80 C. The effects of the fuels on the elastomers and the effects of the elastomers on the fuels were evaluated using visual observations, photomicrographs, infrared spectroscopy, and measurement of hardness, color, gum, and water contents.

25448 (PB–90-148776/XAB) **Assessment of the performance and reliability of older ERW (electric resistance welding) pipelines.** Fields, R.J.; Pugh, E.N.; Read, D.T.; Smith, J.H. National Inst. of Standards and Technology (IMSE), Gaithersburg, MD (USA). Jul 1989. 60p. (NISTIR–89/4136). Available from NTIS, PC A04/MF A01.

On December 24, 1988, a failure occurred in the Ozark Pipeline System in Maries County, Missouri, and resulted in a spill of over 800,000 gallons of crude oil, causing serious contamination of the Gasconade and Missouri Rivers. The pipeline had been in operation since 1949 and the failure occurred in a section of steel pipe produced by electric resistance welding (ERW). A metallurgical investigation by Battelle-Columbus Laboratories concluded that the fracture originated at a defect in the ERW seam weld. At the request of Senators Bond (R-MO) and Danforth (R-MO), NIST assessed the Battelle findings and found them to be sound. NIST also addressed the issue of whether special standards should apply to the operation and inspection of older ERW pipelines. Based on a review of failure incidence data and related documents, it is concluded that, while ERW pipe manufactured prior to about 1970 is inherently susceptible to seam failures, the relatively small number of such failures does not warrant special standards except for critical risk locations. For the latter cases, measures are recommended for failure prevention and, of equal importance, for damage control in the event of isolated failure. Some of these measures are shown to have application to all pipelines.

25449 (PB–90-858747/XAB) **Offshore pipelines. January 1970-January 1990 (A Bibliography from the NTIS dat abase). Report for January 1970-January 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 98p. Available from NTISPC N01/MF N01.

Supersedes PB–88-851894.

This bibliography contains citations concerning the design and construction of offshore pipelines. Design considerations include environmental impact assessment, wave action effects, seabed scouring around the pipeline, protection of installed pipelines, and control systems. Related topics include economic considerations, risk and reliability analysis, and pipe laying techniques. (This updated bibliography contains 176 citations, 12 of which are new entries to the previous edition.)

25450 (TC/MCI–523E) **Report of invertigation into the cirumstances attending the grounding and subsequent hull damage of the Liberian tanker "Filia Star" at Red Island Shoal, Placentia Bay, Newfoundland, March 14, 1988.** Investigation report to the mininster pursuant to sections 542 or 545 of the Canada Shipping Act. . Transport Canada, Ottawa, ON (Canada). Marine Casualty Investigations. [1989]. 27p. (MICROLOG–89-04615). Available from PC Transport Canada, Library and Information Centre, Place de Ville, Tower C, Ottawa, ON, CAN K1A 0N5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report, released for accident preventions purposes, describes and accident undergone by the Fiulia Star, a Liberian medium sized tanker. On the morning of March 14, 1988, the Filia Star entered the Placentia vessel traffic services (VTS) zone. At that time, VTS determined that the vessel did not carry the required charts. While awaiting the delivery of the charts, and under VTS radar surveillance, the Filia Star ran aground on the north side of Red Island Shoal. Within minutes, she was refloated under her own power, and proceeded to Halifax for repairs. The ship did not report the accident until the following day. No pollution resulted as a result of the grounding. The report narrates the sequence of events and analyses them from different points of view: entrance to Placentia Bay, pilotage, weather conditions, damage to the vessel, charts and other publications, Eastern Canada Traffic zone, Placentia Bay vessel traffic services, tankers traffic activity, reporting requirements, radio communications, fuel and ballast, aids to navigation, Placentia pilot Boat, and personnel qualifications. It would appear that the following factors contributed to the grounding: lack of appropriate large scale charts or publications aboard, lack of identification of Red Island shoal buoy, difficulty in radio communications, and failure to stop the vessel with respect to the sea floor as advised by by VTS. 6 figs., 1 tab.

25451 (TC/MCI–523F) **Report of investigation into the cirumstances attending the grounding and subsequent hull damage of the Liberian tanker "Filia Star" at Red Island Shoal, Placentia Bay, Newfoundland, March 14, 1988.** Investigation report to the mininster pursuant to sections 477 or 480 of the Canada Shipping Act (1985). Transport Canada, Ottawa, ON (Canada). Marine Casualty Investigations. [1989]. 28p. (MICROLOG–89-05977). Available from PC Transport Canada, Library and Information Centre, Place de Ville, Tower C, Ottawa, ON, CAN K1A 0N5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report, released for accident preventions purposes only, describes an accident undergone by the Fiulia Star, a Liberian typical medium-size tanker. On the morning of March 14, 1988, the Filia Star entered the Placentia traffic vessel traffic service (VTS) zone. At that time VTS discoverd that the vessel did not carry the required charts. While awaiting the delivery of the charts, and under VTS radar surveillance, the Filia Star ran aground on the north side of Red Island Shoal. Within minutes, she was refloated under her own power, turned around after picking up her charts, and proceeded to Halifax for repairs. The ship did not report the accident until the following day. No pollution resulted as a result of the grounding. The report narrates the sequence of events and analyses them from different points of view: entrance to Placentia Bay, pilotage, weather conditions, damage to the vessel, charts aboard, Eastern Canadian traffic zone, Placentia Bay vessel traffic services, tanker traffic activity, reporting requirements, radio communications, fuel and ballast, aids to navigation, Placentia pilot boat, and personnel qualifications. It would appear that the following factors contributed to the grounding: lack of appropriate large scale charts, lack of identification of Red Island shoal buoy, difficulty in radio communications, and failure to stop the vessel with respect to the sea floor as advised by VTS. 6 figs., 1 tab.

0230 Properties and Composition

Refer also to citation(s) 25300, 25447

25452 (AD-A–216003/4/XAB) **Development of fuel wear tests using the Cameron-Plint High-Frequency reciprocating machine. Interim report, March 1988-May 1989.** Kanakia, M.D.; Cuellar, J.P.; Lestz, S.J. Southwest Research Inst., San Antonio, TX (USA). Belvoir Fuels and Lubricants Research Facility. May 1989. 33p. (BFLRF–262). Available from NTIS, PC A03/MF A01.

The objectives of this program were to develop laboratory bench fuel-wear test methodology using JP-8 and to evaluate the effects of additives to improve load-carrying capacity of JP-8 for use in diesel-powered ground equipment. A laboratory test using the Cameron-Plint High-Frequency Reciprocating machine evaluated the effects of various chemical and physical parameters influencing the lubricity of the distillate fuels. The test conditions were determined sufficient to eliminate the effect of fluid physical properties such as viscosity. It was shown that the differences in the intrinsic lubricity of the fuels were due to small amounts of chemical additives. Under such conditions, the test can be used as a screening tool to find additives for enhancement of JP-8 lubricity. The test has potential to ascertain minimum lubricity level for diesel-powered ground equipment if these requirements are verified with field performance data and determined to be different from the Air Force JP-8 specifications. The dimensionless wear coefficients of Reference No. 2 diesel fuel were shown to be an order of magnitude lower than the jet fuels. In all cases, the wear rates of jet fuels and isoparaffinic solvents were improved by addition of a corrosion inhibitor or antiwear additive to match the lower wear rates of the diesel fuels. Although there was no measurable change in the viscosities of the jet fuel due to the additives, the wear rates changed by an order of magnitude.

25453 (DOE/CE/15444–T1) **Quarterly progress report No. 1 on development of the oil-water monitor.** Swanson, C. Applied Physics Technology, Inc., Great Falls, VA (USA). 30 Sep 1989. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-89CE15444. Order Number DE90008316. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The oil-water monitor is a device which measures water content in crude oil and other petroleum products, in a flowing pipe such as a pipeline or tanker manifold. It has applications in the precise measurement of water contamination levels in crude oil shipments, and is needed to precisely measure and verify oil volumes and contaminant concentrations at petroleum transfer points such as tanker ports, pipeline transfer points, refinery tank farms, or whenever ownership of petroleum products changes hands. The device has been patented, and initial feasibility experiments have been conducted. The present research is directed toward developing and demonstrating a bench model prototype of the oil-water monitor, complete with the computer software and automated microwave equipment and electronics which will demonstrate the performance of the invention, for implementation in full-scale fielded systems. 1 fig.

25454 (DOE/METC–88/6098, pp. 248-257) **The effect of recovery methods on bitumen and heavy oil composition.** Thomas, K.P. (Western Research Institute, Laramie, WY (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The thermal recovery of oil from heavy oil reservoirs has been conducted for many years. In fact, the recovery of oil from these reservoir by steam stimulation and steamflood is economically successful. More recently the application of thermal methods for the recovery of oil from tar sand deposits has been investigated. However, a detailed characterization of the produced oil and how its

properties compare with those of the original bitumen has not usually been a part of the project. These types of characterizations are necessary in order to determine the extent of upgrading that has occurred during the recovery process and to monitor the process during operations. The objectives of this investigation were threefold: (1) to compare the chemical and physical properties of three sets of oil samples, each set composed of the primary and a thermally produced oil from the same pattern area; (2) to determine the potential of producing specification-grade asphalt from the three thermally produced oils; and (3) to compare the asphalt from the three thermally produced oils with refiners' requirements. The samples were obtained from (1) Santa Fe Energy-Midway Sunset (fireflood), (2) Santa Fe Energy-Kern River (steamflood), and (3) Mobil-San Ardo (streamflood). Six tables compare physical and chemical properties of the three primary and thermally produced oils. In general, he properties of the thermally produced oils are outside the range of acceptability for direct refining. Consequently, they are blended with lighter crudes before processing.

03 NATURAL GAS

25455 (PB–90-161225/XAB) **GRI's (Gas Research Institute's) Unconventional Natural Gas Subprogram. Status report. December 1982.** Gas Research Inst., Chicago, IL (USA). Dec 1982. 156p. (GRI–82/7021). Available from NTIS, PC A08/MF A01.

Activities within GRI's Unconventional Natural Gas Subprogram are discussed. The tactical objectives, goals, accomplishments, research strategies, and contract status are described for these project areas: Tight Gas Sands, Eastern Devonian Gas Shales, Coproduction of Gas and Water, and Methane from Coal Deposits.

0302 Reserves, Geology, and Exploration

Refer also to citation(s) 25395, 25396, 25397, 25398, 25400, 25402, 27003, 27004, 27006

25456 (PB–90-142308/XAB) **Studies related to the deep-earth gas: 1984 annual report, January 1984-December 1984.** Gold, T.; Patnaik, P.; Soter, S. Cornell Univ., Ithaca, NY (USA). Center for Radiophysics and Space Research. Dec 1984. 49p. Available from NTIS, PC A03/MF A01.

The research is aimed at determining the importance of the abiogenic methane component in natural gases, and investigating the role and consequences of methane outgassing in a number of natural phenomena. Inverse cracking experiments were conducted along with investigations of the pyrolysis of methane, regional patterns of mixing ratios, and the granitic rock in Siljan, Sweden.

25457 (PB–90-160474/XAB) **Core-analysis results: Comprehensive study wells, Devonian shale. Topical report, May 1989.** Luffel, D.L.; Guidry, F.K. ResTech Houston, Inc., TX (USA). Jul 1989. 102p. Available from NTIS, PC A06/MF A01.

Three important results have been determined based on extensive core analyses on 539 feet of conventional core recovered from four comprehensive study wells in the Devonian shale in the Appalachian area, and based on new methods of core analyses developed. First, relatively high values of porosity and free gas space are present, especially in the black organic rich shales. Second, gas permeabilities have been measured for the first time at native fluid saturations and at in situ pressure. Third, a new method of deriving kerogen content has been developed using geochemistry measurements of total organic carbon and rock pyrolysis. Results show kerogen content is significantly higher than that derived from thin-section petrography, which is the analytical method normally used, by about 50% in the kerogen-rich rocks.

25458 (SAND–89-2612/Pt.B) **Multiwell Experiment final report: 4, The fluvial interval of the Mesaverde Formation: Part B.** Sandia National Labs., Albuquerque, NM (USA); CER Corp., Las Vegas, NV (USA). Jan 1990. 440p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. Order Number DE90007938. Available from NTIS, PC E16/MF E04 - OSTI; GPO Dep.

This report contains 15 microfiche supplements.

The Department of Energy's Multiwell Experiment (MWX) is a field laboratory in the Piceance Basin of Colorado which has two overall objectives: to characterize the low permeability gas reservoirs in the Mesaverde Formation and to develop technology for their production. Different depositional environments have created distinctly different reservoirs in the Mesaverde, and MWX has addressed each of these in turn. This report presents a comprehensive summary of results from the fluvial interval which lies between 4400 ft and 6000 ft at the MWX site. The reservoirs consist of heterogeneous, amalgamated point-bar sequences which form broad meanderbelts which create irregular, but roughly tabular, reservoirs with widths of 1000–2500 ft. Separate sections of this report are background and summary; site descriptions and operations; geology; log analysis; core analysis; in situ stress; well testing, stimulation, fracture diagnostics, and reservoir evaluation in two separate sandstones; stress, fracture diagnostic, and stimulation experiments in an additional sandstone; supporting laboratory studies; and a bibliography. Additional detailed data, results, analyses, and data file references are presented as appendices which are included on microfiche. The results show that stimulation of fluvial reservoirs can be successful if proper care is taken to minimize damage to the natural fracture system. Both an accelerated leakoff phenomenon and the ability to alter the in situ stress were quantified. Overall, the fluvial interval offers the highest production potential of the three nonmarine intervals studied. 116 refs., 230 figs., 28 tabs.

25459 (SAND–2612/Pt.A) **Multiwell Experiment final report: 4, The fluvial interval of the Mesaverde Formation.** Sandia National Labs., Albuquerque, NM (USA); CER Corp., Las Vegas, NV (USA). Jan 1990. 458p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. Order Number DE90007948. Available from NTIS, PC A20/MF A01 - OSTI; GPO Dep.

The Department of Energy's Multiwell Experiment (MWX) is a field laboratory in the Piceance Basin of Colorado which has two overall objectives: to characterize the low permeability gas reservoirs in the Mesaverde Formation and to develop technology for their production. Different depositional environments have created distinctly different reservoirs in the Mesaverde, and MWX has addressed each of these in turn. This report presents a comprehensive summary of results from the fluvial interval which lies between 4400 ft and 600 ft at the MWX site. The reservoirs consist of heterogeneous, amalgamated point-bar sequences which form broad meanderbelts which create irregular, but roughly tabular, reservoirs with widths of 1000–2500 ft. Separate sections of this report are background and summary; site descriptions and operations; geology; log analysis; core analysis; in situ stress; well testing, stimulation, fracture diagnostics, and reservoir evaluation in two separate sandstones; stress, fracture diagnostic, and stimulation experiments in an additional sandstone; supporting laboratory studies; and a bibliography. Additional detailed data, results, analyses, and data file references are presented as appendices which are included on microfiche. The results show that stimulation of fluvial reservoirs can be successful if proper care is taken to minimize damage to the natural fracture system. Both an accelerated leakoff phenomenon and the ability to alter the in situ stress were quantified. Overall, the fluvial interval offers the highest production potential of the three nonmarine intervals studied. 141 refs., 92 figs., 33 tabs.

0303 Drilling, Production, and Processing

Refer also to citation(s) 25427, 25456, 26574

25460 (PB–90-158338/XAB) **Evaluation of hydrogen sulfide conversion processes. Final report, May 1, 1987-October 15, 1989.** Krishnan, G.N.; Pound, B.G. SRI International, Menlo Park, CA (USA). Oct 1989. 95p. Available from NTIS, PC A05/MF A01.

The research was sponsored by the Gas Research Institute to evaluate the status of hydrogen sulfide conversion processes and to recommend areas of research that are of interest to the natural gas industry. Several processes that convert hydrogen sulfide to sulfur and water were reviewed and they include Claus process, Claus plant tail gas treatment processes, liquid phase oxidation

processes and direct catalytic oxidation processes. Electrochemical, photochemical, thermal, thermochemical and plasmachemical methods of producing both hydrogen and sulfur from hydrogen sulfide were also reviewed.

25461 (PB–90-158346/XAB) **Operating GRI's (Gas Research Institute's) Mobil T and C (testing and control) Facility. Tight gas sands research program: Field operations and analysis. Final report, October 1983-November 1988.** Robinson, B.M.; Whitehead, W.S.; Holditch, S.A.; Ely, J.W. Holditch (S.A.) and Associates, Inc., College Station, TX (USA). Nov 1989. 275p. Available from NTIS, PC A12/MF A02.

The Gas Research Institute has implemented a field research program to learn more about the hydraulic-fracturing process. In order to insure accurate and reliable data were collected for analysis, the Mobile Testing and Control (T&C) Facility was built. This equipment was used to collect data on well tests, stress tests, mini-fracs and hydraulic-fracture treatments during the five years of the project. The report summarizes all the work performed using the Mobile T&C Facility, research conducted, and the results of analyses on cooperative research wells in the program.

25462 (PB–90-160078/XAB) **Tight gas sands research program: Field operations and analysis. Cooperative well report; Kerr McGee Corporation, A. A. /Bradley No 1, Smith County, TX. Topical report, December 1987-June 1988.** Holditch, S.A.; Whitehead, W.S.; Robinson, B.M. Holditch (S.A.) and Associates, Inc., Bryan, TX (USA). Aug 1989. 49p. Available from NTIS, PC A03/MF A01.

The Kerr McGee Bradley No. 1 was drilled in December 1987. Five in-situ stress tests were performed. The well was completed in the upper Travis Peak formation at 8145-8317 feet and was fracture treated on February 17, 1988. The well was fracture treated with 162,000 gallons of delay-crosslinked gel and 740,000 pounds of 20-40 Ottawa sand. Average fluid rate was 40 BPM. Treatment diagnostics indicate that the fracture grew uncontained and a radial fracture was created. Propped fracture length was 460 feet.

25463 Detecting compartmentalization in gas reservoirs through production performance. Hower, T.L. (Research and Engineering Consultants Inc. (US)); Collins, R.E. pp. 870 of Proceedings of the 1989 SPE annual technical conference and exhibition: Reservoir engineering. . Society of Petroleum Engineers, Richardson, TX (USA) (1989). (CONF-891049–: Society of Petroleum Engineers annual technical conference and exhibition, San Antonio, TX (USA), 8-11 Oct 1989).

SPE 19790.

Diagnostic techniques are presented for detecting and quantifying poorly drained compartments in volumetric gas reservoirs. It is shown that p/z versus G_p data can be used to assess unrecovered gas reserves and assist in targeting infield development.

0306 Economic, Industrial, and Business Aspects

Refer also to citation(s) 25436, 25912, 25925, 26027

25464 (BCPC–90-00661) **British Columbia Petroleum Corporation annual report 1988-89.** British Columbia Petroleum Corp., Oakville, ON (Canada). [1989]. 14p. (MICROLOG–90-00661). Available from PC British Columbia Petroleum Corporation, 1199 West Hastings St, 6th Floor, Vancouver, BC, CAN V6E 3T5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The British Columbia Petroleum Corporation was established as a provincial Crown agency, whose primary function is to market natural gas produced in the province by purchasing gas from producers and selling it to Westcoast Energy Inc. Westcoast in turn sells it to various domestic utilities and to its principal customer in the USA, Northwest Pipeline. This report summarizes the Corporation's activities for the year ending March 31, 1989 and includes information on sales of natural gas, natural gas liquids, and sulfur, in addition to drilling completions and financial statements. The year under review showed a 19.7% decline in gas sales due to a reduction in deliveries to the export market of over 50%. Factors in this decline included the 1988 offer of Northwest Pipeline to provide open access transportation service, which increased competition and lowered prices, and the decision by Northwest to stop collecting fixed charges for the Westcoast Energy system. The effects of the latter development continued until February 3, 1989, when a settlement of the fixed charges dispute was approved. Since the settlement, exports have recovered and marketing opportunities are more clearly defined. Little change occurred in the domestic market. 4 figs.

25465 (CANWEC–CE02833, pp. 1-23) **Development of a North American natural gas strategy: The approach of a major Canadian producer: Report 3.1.8.** Twiss, W.R. (Petro-Canada, Inc. (Canada)); Preece, R.A. Canadian National Committee, World Energy Conference, Ottawa, ON (Canada). 1989. (CONF-890901–: 14. world energy conference, Montreal (Canada), 17-22 Sep 1989; CE–02833). In *Energy for tomorrow. Division 3: Energy and the economy: Session 3.1: International aspects of energy economics.* Available from Canadian National Committee World Energy Conference, Suite 305, 130 Albert Street, Ottawa, ON, CAN K1P 5G4. Prices: $125.00 CAN.

The natural gas industry in North America is in the midst of a major restructuring-deregulation - that will continue to impact all aspects of the business. Recently, industry revenues have been depressed, but the outlook is brighter, particularly for Canadian producers. The future also poses many risks and natural gas producers challenge is to make the best long-term strategic decisions in this uncertain environment. Petro-Canada recently undertook a comprehensive strategic review of its natural gas business. This paper describes the process that was utilized in developing Petro-Canada's natural gas strategy and outlines the general nature of the major findings of the review. The natural gas strategy development process can be segmented into three broad phases. First, a comprehensive business assessment is carried out from both a macro and a micro perspective. The major analytical tools and approaches the Company utilizes in examining and intergrating both perspectives are discussed in the paper. A key orientation of the business assessment phase is the development of Petro-Canada specific natural gas demand and suppply curves. These curves assist in providing a perspective on the optimal size of Petro-Canada's natural gas business over time. The second phase is the identification and preliminary evaluation of strategic alternatives. The final step is risk assessment and strategy selection. A strategy is then selected with a full appreciation of the risk associated with each alternative and in light of the Company's philosophy toward risk taking.

25466 (CANWEC–CE02833 Report 3.1.9) **Natural gas for a secure future: Outlook for trade with the U.S.: Report 3.1.9.** Waller, D.B. (Dept. of Energy (USA)); Williamson, R.H.; Waldman, A.K. Canadian National Committee, World Energy Conference, Ottawa, ON (Canada). 1989. (CONF-890901–: 14. world energy conference, Montreal (Canada), 17-22 Sep 1989; CE–02833). In *Energy for tomorrow. Division 3: Energy and the economy: Session 3.1: International aspects of energy economics.* Available from Canadian National Committee World Energy Conference, Suite 305, 130 Albert Street, Ottawa, ON, CAN K1P 5G4. Prices: $125.00 CAN.

Energy security is a principle concern of the United States particularly when on going volatility in world oil markets has depressed domestic drilling levels and more oil is required for the transportation sector than is produced domestically. Natural gas is a stable and secure energy resource. This paper describes the United States goverment efforts to streamline and remove regulation which have hampered gas from achieving its most efficient share of energy comsumption. Government regulations has not allowed gas to compete at its fullest level with oil. Acceptance of the concept that the world is composed of interrelated energy markets and cooperation is necessary for all nations to meet common goals of energy security, efficient market allocation of resources, and a cleaner environment, is expanded. This paper describes the potential areas for growth in overall gas demand and demand for imports. 5 refs.

25467 (DOE/EIA–0130(90/01)) **Natural gas monthly, January 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 29 Mar 1990. 146p. Sponsored by U.S. DOE Energy Information Administration. Order

Number DE90009230. Available from NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.

This report highlights activities, events, and analyses of interest to public and private sector organizations associated with the natural gas industry. Volume and price data are presented each month for natural gas production, distribution, consumption, and interstate pipeline activities. Producer-related activities and underground storage data are also reported. From time to time, the NGM features articles designed to assist readers in using and interpreting natural gas information. 7 figs., 34 tabs.

25468 (MPUB–3/90) **Greater Winnipeg Gas Company and ICG Utilities (Manitoba) Ltd. - Application for approval of interim refundable rates flowing from Board Order no. 2/90.** Manitoba Public Utilities Board, Winnipeg, MB (Canada). 5 Jan 1990. 8p. (CE–02979). Available from Manitoba Public Utilities Board, 280 Smith Street, 2nd Floor, Winnipeg, MB, CAN R3C 1K2. Prices: PRICES UPON REQUEST.

This Order flows from Board Order No. 2/90 of January 3, 1990 wherein the Greater Winnipeg Gas Co. and ICG Utilities (Manitoba) Ltd. were ordered to submit a revised schedule of rates, on an interim refundable basis, to be charged to their customers. This document includes that revised rate schedule from the Companies. The Board approved the schedule of rates as presented in its revised form.

25469 (PB–90-142241/XAB) **Economic benefits of the unconventional-gas program at GRI (Gas Research Institute). Annual report, September 1982-June 1983.** Haas, S.M.; Marshalla, R.A.; Nesbitt, D.M.; Oman, D.B. Decision Focus, Inc., Los Altos, CA (USA). 1983. 70p. Available from NTIS, PC A04/MF A01.

See also report No. 2, PB–90-142223.

Analysis shows that, using a five percent real discount rate, the value of overall economic benefits if unconventional gas succeeds rather than fails is 175.47 billion dollars (constant 1982 dollars). The benefits specifically attribute to GRI's activities at existing funding comprise 34.26 billion dollars of the total. Under the assumptions of the study, the magnitude of the economic benefits from GRI's unconventional gas R&D are hundreds of times GRI's annual R&D expenditures.

25470 (PB–90-142316/XAB) **Costs for LNG (liquefied natural gas) imports into the United States. Topical report, August 1988.** Woods, T.; Vidas, E.H. Energy and Environmental Analysis, Inc., Arlington, VA (USA). Aug 1988. 38p. Available from NTIS, PC A03/MF A01.

Cost estimates are presented for the liquefaction, transportation and regasification of liquefied natural gas (LNG). These cost estimates are used to calculate a netback gas purchase price at the liquefaction plant gate in the country of origin given the U.S. wellhead and citygate gas prices determined by the 1988 GRI Baseline Analysis. An annual cost-of-service per unit profile for new regasification facilities that would be subject to U.S. traditional rate-making practices is included.

25471 (PB–90-158312/XAB) **Natural gas vehicles: An update. November 1989.** Gas Research Inst., Chicago, IL (USA). Nov 1989. 13p. (GRI–89/0303). Available from NTIS, PC A03/MF A01.

See also PB–89-204085.

An update is presented of GRI's organization, membership, advisory body structure, funding, R&D results, and industry participation. GRI research in these areas is described: natural gas vehicles, clean coal technologies, waste incineration, interior piping, basic research, high efficiency residential gas space heaters, engine-driven chillers, and advanced glass melters. GRI R&D aimed at reducing environmental impacts and energy costs, increasing efficiency and productivity, and increasing supply security are highlighted.

0308 Environmental Aspects

Refer also to citation(s) 25315, 25471

0320 Transport, Handling, and Storage

Refer also to citation(s) 25449, 25905

25472 (PB–90-142282/XAB) **Definition of advanced gas-distribution subsystems. Topical report, February-June 1983.** Rush, W.F. Institute of Gas Technology, Chicago, IL (USA). Mar 1984. 121p. Available from NTIS, PC A06/MF A01.

Five advanced gas distribution subsystems, using telephone, cable, radio, audio and tracer wires to communicate, were defined to determine their technical and economic feasibility. The study indicates that advanced subsystems using electronic circuits are technically feasible with minor modifications, but they should not be installed individually because complete systems are more cost effective. The tracer system has the greatest capability and lowest cost. Preliminary cost and benefit assessment suggests that advanced distribution systems will be cost effective for some utilities.

25473 (PB–90-158742/XAB) **Development of improved technologies and techniques for reducing base gas requirements in underground gas storage facilities: Simulation study of hanson field gas storage reservoir. Final report, May 1989-November 1989.** Modine, A.D. Scientific Software-Intercomp, Inc., Denver, CO (USA). Nov 1989. 156p. Available from NTIS, PC A08/MF A01.

Base gas requirements in the U.S. amount to a few trillion cubic feet. The Gas Research Institute has proposed a gas storage operating plan whereby an inert gas or a low BTU gas could be injected to replace part of the hydrocarbon gas. A reservoir simulator has been developed, enhanced and tested to solve gas-water reservoir problems where the gas may be treated as a two-component miscible mixture. The previously developed reservoir simulator was further enhanced to include a local grid refinement option, which allows the engineer to study a portion of the field in more detail compared to the rest of the field. The simulator was tested for correctness and completeness. A simulation study was conducted for the Hanson Field Gas Storage Reservoir using two models with different layering. The reservoir history matching was duplicated and several prediction cases were run to study the effectiveness of the replacement of base gas with an inert gas. The results show that replacement of a portion of the hydrocarbon base gas with an inert gas can be an attractive alternative for the gas storage industry.

25474 (PB–90-162991/XAB) **Gas Research Institute status report: Distribution and Storage (3.3) Subprogram.** Gas Research Inst., Chicago, IL (USA). Mar 1984. 107p. (GRI–84/7022). Available from NTIS, PC A06/MF A01.

See also PB–88-205869.

Activities within GRI's Distribution and Storage Subprogram are discussed. The tactical objectives, strategies, results, and contract status are described for these project areas: Construction and Maintenance, Metering and Operations Management, Plastic Piping Materials Evaluation, Residential/Commercial Interior Piping Systems, Gas Storage Technology, Metal Piping Preservation, and Pipe Location.

0330 Properties and Composition

25475 (PB–90-162207/XAB) **Basic research on natural gas combustion phenomena. Annual report, September 1988-August 1989.** Frenklach, M.; Gardiner, W.C. Pennsylvania State Univ., University Park, PA (USA). Davey Lab. 15 Sep 1989. 48p. Available from NTIS, PC A03/MF A01.

See also PB–89-195069.

The objective of the research is to develop a universal chemical kinetic model for the combustion and ignition of methane (and mixtures of methane with other gases, mimicking the composition of natural gas) in terms of elementary chemical reactions with rates specified as functions of temperature and pressure. During the past year a second round of joint parameter optimization of the methane combustion mechanism which can now quantitatively predict both ignition and flame data was completed, analysis of OH profiles collected in a series of hydrogen-oxygen mixtures was conducted, expressions for five elementary reactions were derived, initiated experiments with a CO laser were initiated, CH3 concentration profiles in shock-initiated combustion of ethane were

measured, and data analysis of CH3 profiles in NO-reducing environments and of OH profiles in N2O-H2 mixtures were conducted. A number of manuscripts have been written, submitted for publication, and presented at national and international meetings.

0340 Combustion

Refer also to citation(s) 26028

04 OIL SHALES AND TAR SANDS

0402 Reserves, Geology, and Exploration

25476 (OMNDM/MM–5716) **Stratigraphy and oil shale resource potential of the Middle Devonian Marcellus Formation, southwestern Ontario.** Ontario geological survey open file report 5716. Johnson, M.D.; Telford, P.G.; Macauley, G.; Barker, J.F. Ontario Ministry of Northern Development and Mines, ON (Canada). Mines and Minerals Div. 1989. 166p. (MICROLOG–90-00865). Available from PC Ontario Geological Survey, Geoscience Information Office, Ministry of Northern Development and Mines, 8th Floor, 77 Grenville St., Toronto, ON, CAN M7A 1W4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

There are several shale formations in southern Ontario which are capable of yielding hydrocarbons when heated. Of these units the Middle Devonian Marcellus Formation is probably the least well known. This study examines both the stratigraphy and resource potential of this formation. The work is based on a combination of drill core surveys and organic chemical investigations. Extgensive use was made of down-holes and aided in the identification of organic-rich zones. Results of this study, although notconlcusive due to the small data set used, suggest the following points. The Marcellus Formation is deeply buried below a combination of rock and glacial material, requiring the use of subsurface mining technology for extraction. The organic rich zones in the unit, although they cover an area of several hundred square kilometers are thin (one or two meters), making economic resource extraction unlikley based on present day oil prices. Results from the organic chemical analyses suggest the unit is of moderate hydrocarbon yield relative to the other oil shales present in Ontario. 97 refs., 14 figs., 14 tabs.

0403 Drilling, Fracturing, and Mining

25477 (DOE/METC–88/6098, pp. 285-294) **Oil shale M and MH [mining and material handling] contract meeting.** Knutson, C.F. (EG and G Idaho, Inc., (USA)); Smith, R.P. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The objectives of this project were to assess the current oil shale mining and material handling (M&MH) technology, assemble cost estimates covering M&MH operations and shale oil project unit operations economics, identify novel M&MH research needs/opportunities, and suggest high priority areas for oil shale M&MH research. The assessment was divided into seven tasks: Resource Description; Economic Overview; Review of Extraction Technologies; Research Needs and Opportunities; Economic Impact of Successful Research; Prioritization; and M&MH Suggestions for DOE Oil Shale Program. Major conclusions from the seven assessment tasks are summarized.

25478 (DOE/METC–88/6098, pp. 295-305) **Technology development for blasting based mining operations.** Preece, D.S. (Sandia National Laboratories, Albuquerque, NM (USA)); Thorne, B.J. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The objective of this research is to develop an overall computational model of the blasting process. Processes to be modeled include: detonation of the explosive, expansion of the explosive gases, fracture of the rock mass adjacent to the explosive including particle size, distribution translation of the fragmented material and final settling of the fractured rock. The research will include extensive field and laboratory experimentation to validate the models and, where appropriate, to calibrate engineering approximations. The project also calls for the development of an expert system interface that will permit the complex models to be readily usable on the new generation of desktop computers. The model development will be done in close conjunction with industry which is co-finding the work. A discussion of the significant advances made on the project in the past 12-18 months is presented.

25479 (DOE/METC–88/6098, pp. 306-321) **Evaluation of water-jet-assist mechanical cutting of oil shale.** Kogelmann, W.J. (Alpine Equipment Corporation, State College, PA (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

This project encompasses an evaluation of the technical and economical feasibility of water-jet-assist mechanical mining of oil shale through realistic testing under actual underground mining conditions. It is aimed at the establishment of a technological basis for subsequent private sector development and commercialization of water-jet-assist mechanical mining equipment, through dissemination to the public the data sets requisite to development of a production machine specifically designed for oil shale mining operations. To accomplish this, the contractor will (1) design a water-jet-assist boom-type continuous miner (roadheader) for use in oil shale; (2) modify an existing American-made roadheader; and (3) collect data from actual, underground cutting tests at the Exxon Colony Oil Shale Mine near Parachute, Colorado. After describing oil shale excavation with conventional roadheaders and with water-jet-assist (WFA) roadheaders, the design of the following components are discussed: two cutler head styles; cutter boom; cutting tools; water phasing system; and high pressure water pump.

0404 Oil Production, Recovery, and Refining

Refer also to citation(s) 25281, 25501

25480 (DOE/METC–88/6098, pp. 67-78) **Pyrolysis modeling of oil shale.** Klara, S.M. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The Oil Shale Program at the Morgantown Energy Technology Center (METC) is investigating feasible and practical methods for the conversion of oil shale to useful liquid products. The present focus is on pyrolysis processes with fast (10^5-10^6 °C/s) to rapid (10^6-10^7 °C/s) heating rates. As part of the METC program, the Pyrolysis Modeling Project is responsible for developing the predictive capability required to support the in-house experimental and system analysis research. Presently, modeling activities are concentrated on a flash lamp reactor system (fast heating regime) and a laminar, entrained-flow reactor (LEFR) system (fast heating regime). The modeling approach has focused on reaction kinetics, heat and mass transfer, and multiphase fluid flow. Thus far, this approach has led to the development of the XELAMP (xenon lamp) code for the rapid-heating flash lamp reactor system; and of the PCGC-2 (pulverized coal gasification and combustion) code for the fast-heating LEFR system. Model development for both models is

described. Results on parametric studies with XELAMP are discussed (effects of gas environment and particle size) and model validation is described.

25481 (DOE/METC–88/6098, pp. 79-88) **Lawrence Livermore Laboratory oil shale project: Water generation during pyrolysis of oil shales.** Lewis, A.E. (Lawrence Livermore National Lab., CA (USA)); Coburn, T.T.; Oh, M.S.; Crawford, R.W.; Foster, K.G. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

Oil shale retorting generates shale oil, gas, water, and a spent consisting of residual char and inorganics. Shale oil is the product of value, and its formation has been well investigated. The formation of noncondensable gases is also well understood. However, water generated during retorting has received little attention, even though sources of pyrolysis water and the respective amounts must be known to carry out a satisfactory energy balance; early water release adds significantly to gas flow, perhaps resulting in self-fluidization under certain flash-pyrolysis conditions; and details of water release are also needed to confidently use a new detector that gives isothermal oil shale pyrolysis kinetics. The authors took an MS method developed for gas-evolution studies and modified it by keeping the detector and inlet lines above 125 C so that condensables such as water vapor could be detected. They implemented an accurate water-calibration method and, for the first time, obtained quantitative water-evolution data as they pyrolyzed oil shale.

25482 (DOE/METC–88/6098, pp. 89-98) **Lawrence Livermore National Laboratory oil shale project: Rate of cracking or degradation of oil vapor in contact with oxidized shale.** Lewis, A.E. (Lawrence Livermore National Lab., CA (USA)); Taylor, R.W.; Mallon, R.G. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The object of oil shale retorting is the recovery of oil for transportation fuels. Retorting is done at a temperature range where oil vapors are rapidly released by pyrolysis, generally at 500 C or above. At these temperatures oil vapors tend to decompose by cracking to lighter gases and by coking to char. Light gases, and char have little value. The higher the temperature the more rapid are these oil-loss reactions. Thus rapid removal from the high temperature zone of unstable oil vapors before they are lost by severe cracking and coking is one of the requirements for efficient retorting. These basic facts are known, but accurate data on the rates of coking and cracking are not known. In this report the authors present their experimental measurement of the rate of thermal decomposition of oil vapors. They show that the fraction of oil vapors decomposed under a set of conditions increase when oxidized shale is present, and that the loss is related to the concentration of oxidized shale present. These laboratory measurements help one to understand why flash pyrolysis in the pilot retort, operating with recycled oxidized shale, has not resulted in the enhanced oil yield found by rapid pyrolysis without oxidized shale. They are presently looking into methods reducing oil loss in recycle retorts.

25483 (DOE/METC–88/6098, pp. 145-155) **Lawrence Livermore Laboratory oil shale project: Recent progress in solid-recycle retorting and related laboratory and modeling studies.** Lewis, A.E. (Lawrence Livermore National Lab., CA (USA)); Cena, R.J. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

At LLNL, the authors has constructed and operated a 1 tonne-per-day pilot-scale solid-recycle retorting system, designed from result of controlled laboratory experiments and mathematical models. Operation of the retort has advanced the knowledge of the chemistry and physics of rapid retorting, confirming and also suggesting the need for new laboratory experiments and improvements in the mathematical models. In the LLNL Cascading Bed Retort (CBR) process, raw shale is typically mixed with 4 times its mass of hot recycled shale. Rapid mixing is accomplished by a series of alternating chutes through which the raw and retorted shale pass. The solids then drops into a pyrolyzer where is held while the kerogen decomposes. Pyrolysis gas and oil vapor are quickly swept from the retort, through exit ports, and condensed to minimize coke formation. Solids leaving the pyrolyzer enter a pneumatic lift and are transported to the top of a cascading burner. Combustion of the residual carbon begins in the lift and continues in the burner. The final temperature is controlled by adjusting the lateral flow of air across the burner. Results are discussed on the following: retorting of Western and Eastern shale; sulfur chemistry; solid mixing studies; shale coaling studies; catalytic olefin addition studies; and modeling.

25484 (DOE/METC–88/6098, pp. 156-165) **Kentort II process development.** Carter, S.D. (Kentucky Energy Cabinet Lab., Lexington (USA)); Rubel, A.M.; Taulbee, D.N. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The purpose of this program is to develop on a small scale a process to improve process efficiency, process economics, and resolve environmental problems involved in the utilization of eastern U.S. oil shale as an energy source and chemical feedstock. The process, named KENTORT II, includes fluidized bed sections of pyrolysis, gasification, and combustion with combined solid/gas heat transfer among the stages. The objectives of this design are to: maximize oil generation (130 to 140% of Fischer assay) in a fluidized bed pyrolysis zone; remove most of the sulfur from the char as H_2S prior to combustion to facilitate flue gas cleanup and increase elemental sulfur production; produce solids which are environmentally acceptable for disposal; generate synthesis gas from unused carbon in the pyrolysis char; optimize heat transfer processes; completely utilize mined shale and the energy contained therein; and reduce solid residence time. The main thrust of this program is the study and development of gasification and combustion methods for eastern U.S. oil shale materials and integration with existing fluidized bed pyrolysis technology. The demonstration and testing of the KENTORT II process concept will be performed in a 5lb/hr integrated reactor system. The program is divided into two major areas: the development and integration of fluidized bed oil shale char gasification technology with fluidized bed pyrolysis technology; and the development of oil shale combustion technology; and the development of oil shale combustion technology and integration with pyrolysis and gasification stages. Results described from the first area are: an overview; carbon and sulfur conversion; and gas composition and yield. The text matrix and oil shale sample are described for the integral pyrolysis/gasification operation.

25485 (DOE/METC–88/6098, pp. 166-176) **Surface retorting studies.** Cha Yul Chang (Western Research Institute, Laramie, WY (USA)); Merriam, N.W.; Fahy, J.; Guffey, F. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The objective of this work is to develop new oil shale processing technologies that (1) produce specialty products such as BTX feedstocks, advanced jet fuel feedstocks and improved asphalt binders, (2) produce upgraded oil, and (3) produce greater oil yields than other pyrolysis processes. The ROPE (Recycle Oil Pyrolysis and Extraction) process development program consists of (1) construction of a 6-inch diameter bench-scale unit (100 lbs/hr capacity), (2) completion of a 10-day shakedown test using New Albany oil

shale, and (3) performing New Albany oil shale tests in a 2-inch diameter screw reactor to determine oil yield and characteristics at steady-state. The IFB (inclined fluidized-bed) process development includes (1) retorting oil shale with steam in the first stage of the IFB (10 lbs/hr capacity) and burning the retorted shale in the second stage of the IFB, and (2) combustion of eastern and western oil shales in the IFB. Heavy oil yield and combustion efficiencies of raw and retorted shales are determined from the IFB reactor tests. Results available from both processes are discussed.

25486 (DOE/METC–88/6098, pp. 177-186) **Perform research in process development for hydroretorting of eastern oil shales.** Rex, R.C. Jr. (HYCRUDE Corporation, Chicago, IL (USA)); Hu, W.C.; Punwani, D.V.; Lau, F.S.; Roberts, M.J. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The program is divided into five main tasks. (1) Hydroretorting Characteristics focuses on the expansion of the existing data base for an Indiana New Albany shale and the generation of similar data base for five additional eastern oil shales from Alabama, Tennessee, Ohio, Michigan, and Kentucky. (2) Process Efficiency Improvement Test investigates two concepts: (a) Synthesis gas retorting - to determine the effects of synthesis gas composition and its synergism with operating temperature and pressure on the retorting characteristics of eastern oil shales and (b) Mist generation - to determine the potential of reducing oil refluxing by the introduction of charged gas particles (CO_2) into the product gas stream, thereby increasing product oil yields. (3) Fines Utilization Test investigates two concepts: (a) Fines gasification tests - to evaluate the potential using shale fines for producing synthesis gas or hydrogen for hydroretorting oil shales through gasification of shale fines and (b) Cold-flow model studies - to determine the effects of fines concentration on gas distribution in a moving packed bed of oil shales. (4) Process Designs/Environmental Mitigation develops conceptual process designs for a moving-bed hydroretorting facility; identifies range of concentration for potential pollutants, appropriate environmental regulations, suitable control technology, and effluent streams for a moving-bed hydroretorting plant; and investigates the differences between a conventional conceptual thermal retorting plant and a moving-bed hydroretorting plant utilizing the same eastern oil shale. (5) Sample Procurement provides geologically documented and representative samples for the experimental programs conducted under the cooperative agreement. The status and available results from all five tasks are described.

25487 (DOE/METC–88/6098, pp. 187-199) **Beneficiation-hydroretort processing of US oil shales: Project review and conclusions.** Rampacek, C. (Univ. of Alabama, Tuscaloosa (USA)); Lamont, W.E.; Hanna, J.; Rex, R.C. Jr. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The objective of the three year program were to: assess the response of various U.S. oil shales to beneficiation-hydroretort processing; optimize the beneficiation process variables in tests of three selected shale and study the potential environmental impact associated with beneficiating Eastern Oil shale; and design conceptual commercial plant flowsheets for beneficiation and hydroretorting of Eastern Oil shales, and prepare economic evaluations of the combined beneficiation-hydroretort processing approach for maximizing oil product extraction from the Eastern shales. The research completed to date has demonstrated the merit of combined beneficiation-hydroretorting for maximizing oil recoveries from low yield Eastern oil shales. A preliminary economic study has shown that processing beneficiated Alabama and Kentucky oil shales by beneficiation-hydroretorting reduces the projected selling price of oil by as much as 23 and 16%, respectively, when compared to hydroretorting the raw shales alone. The technology developed during the term of this project has enhanced the importance of Central and Eastern oil shales as a potential national future energy resource.

25488 (DOE/METC–88/6098, pp. 200-210) **Pressurized fluidized-bed hydroretorting of eastern oil shales.** Bonner, W.P. (Institute of Gas Technology, Chicago, IL (USA)); Chiang, S.H.; Fogler, H.S.; Knowlton, T.M.; Lau, F.S.; Mensinger, M.C.; Pfister, R.M.; Rampacek, C.; Roberts, M.J.; Wasam, D.T. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The overall objective of the program is to perform the research necessary to develop a pressurized fluidized-bed hydroretorting (PFH) process for producing oil from Eastern oil shales. In addition to obtaining data for the PFH process, the program also incorporates research on technologies in areas such as raw shale preparation, beneficiation, product separation, and waste utilization and disposal that have the potential to improve the economics and/or the environmental acceptability of the PFH process. The various currently active program tasks are grouped into the following areas: Lab-Scale PFH Test, Beneficiation Research, Shale Desulfurization Research, Beneficiated Shale Fluidization Test, Restricted-Pipe Discharge System Studies, and Environmental Data and System Analyses. Discussion on each of these areas follows. Available results are then discussed.

25489 (DOE/METC–88/6098, pp. 211-218) **Conceptual design of commercial oil shale plants.** Albulescu, P. (Roster Wheeler USA Corporation, Clinton, NJ (USA)); Gaire, R.J. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The overall scope of Foster Wheeler's contract included five conceptual design cases, to be executed at DOE's option, for the nominal production of 50,000 BPD of syncrude based on processing run-of-mine shale in a grassroots facility. The design cases are: Base Case - Fluidized-bed retorting/combustion of Colorado Mahogany zone shale; Option-1 - Alternate base case, design employing an FCC (fluidized - bed catalytic cracking) concept of fluidized-bed retorting/combustion of Colorado Mahogany zone shale; Option-2 -Directly heated moving vertical-bed process using Colorado Mahogany zone shale; Option-3 - Fluidized-bed retorting/combustion of eastern U.S. New Albany shale; and Option-4 - Directly heated moving vertical-bed process using eastern U.S. New Albany shale. Foster Wheeler conducted three conceptual design studies in accordance with DOE's Base Case, Option-1, and Option-2 alternates. Specifications for the major process equipment items were prepared for all plant sections from which detailed capital cost estimates were developed. The design bases for the three retorting systems, as developed from literature data, are summarized. Side-by-side FCC-type arrangement for fluidized bed retorting is considered to present less technical risks, with comparable economics, to gravity flow design with lift pipe combustion. While net operation costs are comparable for fluid bed and moving bed retorting plants, the fluid bed plant design is 20% more capital intensive. At best, fines combustion in moving bed retorting (Option-2B) is marginally attractive. Formation, and subsequent removal from shale oil and process streams, of fine particulates and trace contaminants are critical R&D areas.

25490 (DOE/METC–88/6098, pp. 219-228) **Comparison of western and eastern oil shale conversion in a staged fluid-bed system.** Gregoire, C.E. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the*

third annual oil shale, tar sand, and mild gasification contractors review meeting. Order Number DE88010257. Available from NTIS, PC A21/MF A01.

A staged fluid-bed oil shale retorting process flow sheet model was developed using the ASPEN process simulator to address the conversion of oil shale in a hot solids recycle retort. The conversion of an eastern and a western oil shale are compared, utilizing data gathered by the Western Research Institute as part of the reference shale characterization activity. Operating parameters studied include feed shale grade, retort temperature and residence time, and recycle shale temperature. A range of values was examined to determine the effects on net oil yield, stream compositions and flow rates, and vessel size. The model includes pyrolysis and vapor-phase oil cracking kinetics, particle entrainment, char and supplemental fuel combustion, and mineral decomposition reactions. The lower percent conversion of kerogen to oil in an eastern shale resulted in a higher raw shale feed rate for a set oil production rate and required a lower extent of char conversion in the combustor. The potential increase in oil yield above Fischer Assay yield for eastern oil shales was examined. The paper describes the process and its flowsheet, discusses the case study results, and summarizes conclusions from this study.

25491 (DOE/METC–88/6098, pp. 236-247) **Fundamental chemistry and physics of recovery processes.** Guffey, F.D. (Western Research Institute, Laramie, WY (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The Western Research Institute is currently developing the ROPE concept for the recovery of distillable liquid products form alternate fossil fuel sources such as tar sand and oil shale. The processing concept is based on recycling a fraction of the product oil back into the reactor with the raw resource. The conversion of the solid resource to a liquid fuel is performed in two stages. The first recovery stage is performed at moderate temperatures (325-420 C) in the presence of product recycle oil. The second stage is preformed at elevated temperatures (450-540C) in the absence of product recycle oil. Research has been performed using 3-inch and 6-inch process development units (PUD) and has investigate the recovery of liquid products and solving engineering problems involved in developing a commercial process. The PDU investigations, because of the large scale and complexity of the reactor system, have not provided data that can be used to understand the fundamental processes that occurred during conversion. For this reason, predictive capabilities have not been developed and an understanding of the steady-state properties of the process and the products has not been achieved. This paper describes results from evaluations of the tar sand pretreatment zone, the recycle oil pyrolysis zone, and the recycle oil reflux zone.

25492 (DOE/METC–88/6098, pp. 258-266) **Recycle oil pyrolysis and extraction process.** Cha Yul Chang, Fahy, J. (Western Research Institute, Laramie, WY (USA)); Guffey, F.D. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The overall objective of this research is to develop a process which gives greater oil yield from tar sand than the existing processes and which may produce upgraded fuel feedstocks. The Recycle Oil Pyrolysis and Extraction (ROPE) process consists of two pyrolysis steps: (1) retorting tar sand at a relatively low temperature (T < 430 C) with product oil recycling, and (2) completing the pyrolysis of residue at a higher temperature (T > 430 C) in the absence of product oil recycling. To develop the ROPE process, WRI has constructed and operated a 2-inch diameter process development unit (PUD) using screw reactors. Also, WRI has constructed an inclined liquid fluidized-bed reactor system (10 lbs/hr capacity) to provide an alternative reactor system for ROPE process development. Results obtained from the PDU strongly indicate that the ROPE process would provide the solution to the problems associated with tar sand processing. Consequently, WRI has constructed a 6-inch diameter bench-scale unit (BSU [screw reactor system]) which has a capacity of 50 to 100 lbs/hr 10 studies and mathematical model development to support the RORE process development. Results are discussed from the following: 2-inch PDU tests; 6-inch bench-scale unit test; and the use of ROPEE product oil as a bitumen diluent.

25493 (DOE/METC–88/6098, pp. 322-333) **In situ oil shale retorting studies.** Merriam, N. (Western Research Institute, Laramie, WY (USA)); Chang Cha Yul. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

It is well established that blasting oil shale to create in situ retorts does not produce uniform permeability. Retorting tests were conducted in the WRI 10-ton retorting system using a constant grade of oil shale. Zones of contrasting permeability were created by loading particles of one size distribution into part of the retort and particles of a different size distribution into part of the retort and particles of a different size distribution into another part of the retort while retracting a barrier device as loading progressed. The shale grade and inlet gas flow were essentially constant in test S71 through S79, making the degree of permeability contrast between zones and the size of the contrasting zones the only variables in the series of tests. In tests S80 and S81 propane was injected into the retort to demonstrate that external fuel could be used without knowing the size or location of highly permeable zones. Coal dust was used in test S82 and S83. The following are conclude as a result of these tests. External fuel can be used to improve the yields from retorts with nonuniform permeability. Coal and propane were successfully used to heat areas behind the retorting fronts and to improve yields. The heating value of the incremental oil and gas produced exceeded the heating value of the external fuel used in every tests. A low-cost external fuel such as coal (and perhaps oil-rich shale) can be used to produce additional oil. Coal dust can be distributed into a zone with high permeability by injecting the dust into the inlet air stream.

25494 (DOE/METC–88/6098, pp. 334-341) **Economic study of rf heating by phased arrays of dipole antennae.** Inguva, R. (Univ. of Wyoming, Laramie (USA)); Baker-Jarvis, J. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The object of this study is to estimate the economic viability of recovering oil from oil shale by heating with dipole applicators. In the process the authors assume that various wells are drilled into the resource and in each well a dipole or monopole applicator is installed. The spacing of the wells is a function of the applied frequency. Frequencies in the range of 1 to 50 Mhz have been found to be optimum. The attenuation lengths at these frequencies are from 2 to 200 meters. The process is invisioned as consisting of arrays of dipoles or monopoles inserted into the resource. The well spacing is assumed to be $\lambda/2$, and phase shifters exist between the various applicators. The wells are operated in unison, however, when overheating is noted at a particular well, the powder affecting this spot may be decreased. The phasing takes place according to model results to optimize the uniformity of heating. The oils flows through the induced permeability to recovery wells by the autogeneously produced pressure. The authors assume in the analysis that the retort temperature occurs at 400C which is low enough so that the carbonates are not reacted (which is an endothermic reaction). This is an important assumption since this reaction requires a lot of energy. Also, they assume that only a small fraction of the oil is vaporized. The present study does not include the price of drilling and r.f. equipment.

25495 (DOE/METC–88/6098, pp. 355-361) **Fluidized-bed pyrolysis of bitumen-impregnated sandstone.** Oblad, A.G.; Hanson, F.V. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The fluidized-bed pyrolysis of bitumen-impregnated sandstone has been evaluated as a potential method for the exploitation of Utah's tar sand deposits. The deposits investigated to date include Sunnyside, Tar Sand Triangle, Whiterocks, and PR Spring. The primary objective of the fluidized-bed research program is to develop a data base from which a commercial pilot facility can be designed. A series of preliminary experiments with the Circle Cliffs tar sand have led to a downgrading of the potential for this deposit as a source of bitumen-derived hydrocarbon liquids. The hydrocarbon liquid yield was significantly decreased relative to the yields obtained with the other deposits. In addition, copious quantities of water were produced during the pyrolysis process. Circle Cliffs mineral substrate contained a significant amount of kaolinite (as much as 14% by weight) which contained a substantial amount of bound water which was released at the pyrolysis temperatures. Furthermore, the activated kaolinite functioned as a cracking catalyst at the pyrolysis temperatures causing a shift in the product distribution from C_5^+ hydrocarbon liquid to C_1-C_4 hydrocarbon gases. The continuous operation of the large-diameter fluidized-bed pilot unit to produce a bitumen-derived hydrocarbon liquid from the Whiterocks tar sand for subsequent studies, had led to the development of a number of proposed modifications to the unit which should improve future operations, thus permitting long-term production runs. A preliminary mathematical model of the diffusion dominant regime was developed to describe the bitumen-pyrolysis process; however, it must be modified before it can be satisfactorily tested against experimental data.

25496 (DOE/METC–88/6098, pp. 362-370) **Heat pipe pyrolysis and combustion.** Seader, J.D. (Univ. of Utah, Salt Lake City (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The primary objective of this project is to develop and demonstrate an efficient, economical, and operable process and apparatus, based on advance heat-pipe technology, for recovering bitumen from tar sands. More specifically, the process is a fluidized-bed thermal process that produces a cracked bitumen, which, after hydrotreating for nitrogen removal, is a high-grade synthetic crude oil suitable for processing in a petroleum refinery. The process does not require solvents, process water, or the recycle of large amounts of sand as in other processes for bitumen extraction. The process and equipment are described, and results of performance testing are discussed.

25497 (DOE/METC–89/6100, pp. 61-72) **Solvent dedusting of shale oil with mixtures of light alkanes and alcohols.** Taylor, J.L. (Amoco Oil Company, Naperville, IL (USA)). USDOE Morgantown Energy Technology Center, WV (USA). 8 Dec 1988. (CONF-881227–: Separation technology workshop for coal gasification, Morgantown, WV (USA), 8 Dec 1988). In *Proceedings of the separations technology workshop for coal gasification.* Order Number DE89000905. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

In the above-ground retorting of oil shale, large quantities of colloidal, inorganic particles carry over into the liquid products. A method for removing these dust particles from the shale oil is described. This separation is affected at atmospheric pressure by solvent extraction with mixtures of light alkanes and alcohols. The dust content of a full boiling range shale oil can be reduced from 15 to below 0.2 wt% while recovering 98 wt% of the shale oil. The dust separates from the solvent-oil mixture at rates exceeding 100 ft/hr. The solvents can be efficiently reclaimed from the dedusted oil and dusty sludge using low-grade steam.

25498 (NBNRE–89-45) **New Brunswick oil shale: Technological characterization and Petrosix pilot plant retorting tests.** Filho, F.F.; Vasconcelos, D.; Novicki, R.E.M. New Brunswick Dept. of Natural Resources and Energy, Fredericton, NB (Canada). Minerals and Energy Div. Nov 1989. 162p. (MICROLOG–90-00978). Available from PC New Brunswick Legislative Library, Government Documents Section, 766 King Street, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A testing program was initiated to evaluate the feasibiilty of the Petrosix process for retorting New Brunswick oil shales. Samples representative of the Albert Mines Zone and the Dolomite Marlstone Zone were characterized to define the more important physical and chemical properties of the shales, then the samples were tested in the Petrosix pilot plant. Results are reported for the pilot tests, including process conditions, laboratory analyses, mass balance, elemental and heat balances, and process yields. The two shales showed some differences in mechanical strength to abrasion and in particle sphericity, but still have properties within the range of values for oil shales previously tested for the Petrosix process. The Albert Mines sample exhibited a moderately high level of thermal degradation, and the Marlstone sample shows evidence of carbonate decomposition reactions in the temperature range corresponding to organic matter liberation. In the pilot tests, the largest difference between the two shales was in the average processing rate, with the Albert Mines sample having a lower retorting rate. The results suggest that the recommended processing rate is about 2,000 kg/h/m^2. The pilot plant showed a smooth operation and a high retorting efficiency for both samples as indicated by the values of product yields obtained. 12 figs., 15 tabs.

0405 Properties and Composition

25499 (DOE/METC–88/6098, pp. 229-235) **Property determination and reference resource selection.** Thomas, K.P. (Western Research Institute, Laramie, WY (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The objective of this project is to select and acquire material from tar sand deposits that are suitable for the development of in situ and surface thermal recovery processes. The base-line data obtained on these materials is used to aid in process development, provide input for mathematical model development, evaluate production mechanisms, and determine the extent of produced oil upgrading. This paper contains a listing of tar sand deposits organized by state or area that contain bitumen in concentrations greater than 750 barrels/acre-foot. This concentrations was chosen because this is the minimum concentration of bitumen in the ore that is needed for in situ recovery process development. With these considerations, deposits in California, Kentucky, New Mexico, Texas, and Utah were identified as possible sources of material. Three tar sand deposits which are suitable for in situ and surface (bench-scale hot oil extraction) recovery process development were selected. The sources of these samples were the Unitah county quarry near Vernal, Utah (Asphalt Ridge deposit); the Great Northern Corporation mine site near Price, Utah (Sunnyside deposit); and an outcrop near Edna, California (Arroyo Grande deposit). Elemental compositions, physical properties, chromato graphic compositions, infrared functional group analysis data, and molecular weight data are given for the three tar sand bitumens.

25500 (DOE/METC–88/6098, pp. 267-277) **Fuels ecursors and product end use potential.** Marchant, L. (Western Research Institute, Laramie, WY (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The objective of these project was to evaluate the product oils from three different experimental recovery processes for fuels and end use potential. The first project evaluated liquid products for a process, developed at the Western Research Institute (WRI) called ROPE (Recycled Oil Pyrolysis and Extraction). The second project evaluated the product oil from a bench-scale in situ wet forward combustion process. The third project evaluated the product oil (called TS-IS oil) from the DOE in situ tar sand steamflood project at Vernal, Utah. The first two projects used Asphalt Ridge tar sand and the third project used Northwest Asphalt Ridge tar sand. After a brief description of each process, results on the physical and chemical characterization of the product oils are presented.

25501 (DOE/METC–88/6098, pp. 342-354) **Modified hot water extraction.** Oblad, A.G.; Miller, J.D. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The typical nature of Utah tar sands and their inability to yield satisfactory recoveries in hot water processing have led to the belief that the bitumen in these deposits is in intimate contact with the sand grains. If indeed this is the case, it becomes essential to understand the nature and magnitude of the interactions that are operating at the sand/bitumen interface so that effective strategies can be developed to overcome these interactions to achieve improved recoveries. One of the objectives in this segment of the project is to evaluate the cohesive forces comprising the bitumen that occurs in Utah tar sands, with a particular emphasis on high viscosity bitumens, and also an estimate of the adhesive forces that are prevalent between bitumen and sand surface. The project work would involve the determination of surface tension of selected high viscosity bitumens under different sets of conditions. For contact angle measurements, pure quartz and silica would be used as ideal solid surfaces. These experiments would be conducted at different temperatures and pH values. Studies will be initiated to determine the feasibility of caloric measurements to determine the enthalpy changes that occur when bitumen is brought in contact with finely-powdered silica or quartz. Since bitumen is an extremely viscous material, some experimental difficulties may have to be overcome by performing these studies on solutions of bitumen in relatively inert solvents. This may necessitate the measurements of heats of dilution of bitumen and heats of suspension of solids in the selected solvent. Results to data are described.

0407 Health and Safety

25502 (DOE/ER/60199–1-Vol.1) **Studies of the Scottish oil shale industry: Volume 1, A socio-historical study of Scottish shale mining communities in Mid and West Lothian: Final report.** Randall, S.C. Institute of Occupational Medicine, Edinburgh (UK). Mar 1990. 90p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-84ER60199. Order Number DE90009160. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

An oral history of life in the first half of the twentieth century in the shale mining communities of Mid and West Lothian, Scotland provided background information needed for a mortality study of these communities where the Scottish shale oil industry was located until 1963. Thirty-two semi-structured interviews with 41 old people provide a detailed socio-historical picture of life in an area dominated by this industry. Much of the information is presented using quotations from the interviews. Housing conditions and perceptions of pollution are described. Details of working conditions, jobs and wages, focussing in particular on the shale industry, suggest that until the early 1920s shale workers were financially well off compared with workers elsewhere. Comparative wage levels then deteriorated until 1939. Women's activities, roles, domestic and work positions indicate that although women had little exposure to industrial hazards in the workplace, their standard of living was very low and they had to work extremely hard. Health and health care, diet, smoking and drinking habits, leisure and migrations are other factors which could affect morality patterns. Comparisons with contemporary studies are discussed. 33 refs., 6 tabs.

25503 (DOE/ER/60199–1-Vol.2) **Studies of the Scottish oil shale industry: Volume 2, Mortality in the Scottish shale mining communities: Final report.** Randall, S.C.; Cowie, H.A.; Hurley, J.F.; Jacobsen, M. Institute of Occupational Medicine, Edinburgh (UK). Mar 1990. 128p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-84ER60199. Order Number DE90009161. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This study aimed to identify any adverse impact of the shale industry on mortality in communities in Scotland where oil shale was extracted and processed until 1962, when the industry closed. Civil Parishes in the study area were classified as 'Shale', 'Coalmining' or 'Rural' according to levels of shale and coal industry activity during or shortly before those periods over which mortality was monitored. Information about the population at risk in these areas, and mortality, was obtained primarily from official sources, supplemented by ad hoc investigations of specific problems. Mortality analyses focused on malignant causes 1953–81 and non-malignant causes 1963–81; mortality from all causes, 1911–31, was also examined. 27 refs., 18 figs., 54 tabs.

0408 Economic, Industrial, and Business Aspects

Refer also to citation(s) 25502

25504 (PB–90-142258/XAB) **Economic evaluations of four GRI (Gas Research Institute) unconventional-gas project areas. Annual report, September 1982-June 1983.** Haas, S.M.; Marshalla, R.A.; Nesbitt, D.M.; Oman, D.B. Decision Focus, Inc., Los Altos, CA (USA). 1983. 94p. Available from NTIS, PC A05/MF A01.

See also report No. 3, PB–90-142241.

Analysis shows that the value of economic benefit (measured at a five percent discount rate) specifically attributable to each of GRI's four unconventional gas research areas is computed as: western tight gas sands, 18 billion dollars; eastern Devonian gas shales, 5 billion dollars; methane from coal deposits, 8.6 billion dollars; and geopressured aquifers, zero (not likely to penetrate the market). The economic benefits calculation reflects the cost of fuel displaced relative to the cost of the gas provided. The magnitudes of economic benefits for these project areas far exceed the annual research budget for unconventional gas at GRI.

0409 Waste Management

25505 (DOE/METC–88/6098, pp. 278-284) **Effluent characterization for field and laboratory recovery processes (tar sand).** Nordin, J. (Western Research Institute, Laramie, WY (USA)); Barker, F.; McTernan, W.F. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

Initial work at Western Research Institute consisted of characterization of process wastewater and completing wastewater treatment studies for an in situ steamflood field experiment conducted on Northwest Asphalt Ridge near Vernal, Utah (TS-IS). This 160-day steamflood produced 1150 bbl of oil and 6250 bbl of water and consumed 65,700 bbl of water-equivalent steam. A portion of this wastewater was transferred in polyethylene-lined drums to Western Research Institute (then known as the Laramie Energy Technology Center) for chemical and physical characterization and for bench-scale treatability studies. Western Research Institute continued to characterize effluents from bench-scale laboratory tests simulating in situ processing of tar sand. Tests were carried out simulating a steamflood, steam and combustion, or combustion only. Process water from the various tests were collected for detailed characterization. Later, solids, liquids, and gaseous effluents were sampled from some tests for trace metal analysis. Off gases were also sampled during the course of the tests for carbon dioxide, hydrogen, carbon monoxide, hydrocarbons to C_4, nitrogen, argon, nitric oxide, hydrogen sulfide, sulfur dioxide, mercaptans, and carbonyl sulfide.

Solid residues from some tests were subjected to the U.S. Environmental Protection Agency Extraction Procedure leaching test, which is used to determine whether a solid waste is hazardous. Raw (unprocessed) Asphalt Ridge and Sunnyside tar sands samples were cryogenically ground in a SPEX shatterbox to less than 100 mesh and then analyzed for trace metals. Results are presented for the following: wastewater; trace elemental analyses; sulfur species/nitric oxide in off gas; and organic vapors in off gas.

0410 Environmental Aspects

Refer also to citation(s) 25502

25506 (PB–90-141300/XAB) **Unocal Parachute Creek Shale Oil Program. Environmental Monitoring Plan, Quarterly report. Second quarter 1989. Report for 1 April-30 June 1989.** Unocal Corp., Parachute, CO (USA). Energy Mining Div. 31 Aug 1989. 585p. (REPT–89-2Q). Available from NTIS, PC A25/MF A04.

See also PB–89-191043.

The Energy Security Act of 1980 established a program to provide financial assistance to private industry in the construction and operation of commercial-scale synthetic fuels plants. The Parachute Creek Shale Oil Program is one of four projects awarded financial assistance. The Program agreed to comply with existing environmental monitoring regulations and to develop an Environmental Monitoring Plan incorporating supplemental monitoring in the areas of water, air, solid waste, and worker health and safety during the period 1985-1992. These activities are described and the rationale for Tier I and Tier II monitoring are explained in the Environmental Monitoring Plan.

05 NUCLEAR FUELS

Refer also to citation(s) 25751, 26364

0501 Reserves, Exploration, and Mining

Refer also to citation(s) 25395, 25396

0505 Uranium Enrichment

Refer also to citation(s) 25530, 25603, 25615

25507 (CONF-880558–, pp. 231-233) **Configuration control of safety systems.** Johnson, E.R. (Paducah Gaseous Diffusion Plant, KY (USA)). Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

The introduction of safety system to the gaseous diffusion plants gave rise to the need for some method of assuring that the testing, identification, and changes to safety system are reviewed and controlled by authorized personnel. This need has been satisfied through the implementation of a configuration control system. The configuration control system involves each major division of the plant and provides a record of the tests, maintenance activities and a historical record of these activities for each safety system.

25508 (CONF-880558–, pp. 215-220) **UF_6 cylinder inspection and test facility at Paducah Gaseous Diffusion Plant.** Lamb, G.W. (Paducah Gaseous Diffusion Plant, KY (USA)); Whinnery, W.N. III. Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

Paducah cylinder washing and testing facility operations are described for the cleaning of 10- and 14-ton uranium hexafluoride (UF_6) cylinders. Decontamination solution preparation and maximum reuse of solution are explained. Cylinder inspection parameters before and after cleaning a cylinder are detailed on data tables. Cleaning procedures for a 10- and 14-ton cylinder are outlined and the equipment is shown in photographs and process diagrams. A 12-point radiation survey of the cylinder before and after cleaning is used in protecting the worker and maintaining exposure to radiation as low as reasonably achievable (ALARA). The inspection of UF_6 cylinders in required for new, in-service, and damaged cylinders as detailed in the criteria in ANSI N14.1 and Oak Ridge Operation ORO-651. Criteria and inspection procedures for the replacement of 1-inch UF_6 cylinder valves and 1-inch and 1 1/2-inch cylinder plugs and the parameters for thread engagement of valves and plugs are outlined. A uniform method of measurement for thread insertion made on both valves and plugs is described. Specialized equipment to facilitate installation of the plug and valve and reduce worker exposure to undue hazards are described. Hydrostatic testing of cylinders, drying, and evacuation are part of the Chemical Operations Department's function and they are presented in the paper. Also discussed is the refurbishment of 1-inch UF_6 cylinder valves.

25509 (CONF-880558–, pp. 227-230) **History of UF_6 handling committee.** Sykes, W.E. (Paducah Gaseous Diffusion Plant, KY (USA)). Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

UF_6 handling operations at the Department of Energy (DOE) gaseous diffusion sites have been performed in a very safe manner since start-up of uranium enrichment plants. Department of Energy Oak Ridge Operations Office (DOE-ORO) and gaseous diffusion plant contractor management were aware of the need to continue this safe level of handling performance and identify new approaches for further improvements of the overall safety of UF_6 handling. One such new approach was the formation of the UF_6 Cylinder Handling Committee in 1973. The first major effort completed by this committee was a comprehensive review of all UF_6 handling activities at the three gaseous diffusion plants. This review resulted in the development of 133 recommendations that describe procedures or operating methods for safe UF_6 handling operations. These recommendations are still for safe UF_6 handling practices at the DOE-ORO sites. Several of these recommendations have resulted in significant improvements in safety at the DOE sites and also a to private companies who have adopted the practices into their operating procedures and are covered in this document. The UF_6 Handling Committee continues to be our main approach to interplant communication addressing problems and standardization of UF_6 handling related activities.

25510 (KAERI/RR–787/88) **Nuclide separation process.** Kim, Sung Hyun (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Byun, Kee Hoh; Park, Jeong Hwa; Yoo, Jae Hyung. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Feb 1989. 222p. (In Korean). Order Number DE90623194. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

An on-line process monitoring system was developed and successfully demonstrated in this work.The system will be able to enhance the reliability as well as safety of a chemical process when applied to a large-scale commercial process. The equipment composed of the system is as follows: A chemical reactor, sersors, a micro-computer, interfacing units and a multi-channel counter with its accessaries. The software for the data acquisition, which is deviced in this study was incorporated in the computer system. The process variables such as temperature, liquid level, liquid density and radioactivity of product were exactly measured on the real time basis and graphically shown on a monitor. (Author).

0507 Fuels Production and Properties

Refer also to citation(s) 25770, 25801, 25940, 26271, 26283

25511 (WSRC-RP–90-233) **Equipment upgrades for the Pu-238 program.** Congdon, J.W.; Stephens, W.D.; Marra, J.E.; Nelson, G.H. Westinghouse Savannah River Co., Aiken, SC (USA).

14 Feb 1990. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009123. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Much of the equipment and instrumentation in the Pu-238 production facilities is more than 15 years old. Significant improvements have been made in the available instrumentation, in particular, due to the application of microprocessors and lasers. The Actinide Technology Section of SRL has selected and is in the process of evaluating several state-of-the-art instruments which have potential applications in the Pu-238 program. The ease of operation and the accuracy of the instruments have been improved and, in most cases, the cost of the instruments have decreased. 5 refs.

0508 Spent Fuels Reprocessing

Refer also to citation(s) 25541, 25562, 25569, 25614, 26276, 26281

25512 (ENEA-RT-COMB–88-03) **EUREX plutonium liquid-solid conversion plant operating manual: Design, equipment, operation.** Alonzo, G.; Hall, A.; Pozzi, F. ENEA, Casaccia (Italy). Dipt. Ciclo del Combustibile. Jun 1989. 18p. (In Italian). (RT/COMB–88-3). Order Number DE90764348. Available from NTIS (US Sales Only), PC A03/MF A01.

A unit for liquid-solid conversion of plutonium recovered during the reprocessing campaign of Candu irradiated fuels has been recently put in operation at the ENEA (Italian Commission for Alternative Energy Sources) EUREX plant of Saluggia (Italy). The unit, the auxiliary services, the control and security systems and the health physics equipments are described in the report. The conversion process, based in Gel Supported Precipitation (GSP) and the throughput of the unit are also described.

25513 (Juel–2304) **Incineration of irradiated graphite fuel elements in a fluidized bed.** Ringel, H. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Chemische Technologie der Nuklearen Entsorgung. Aug 1989. 34p. (In German). Available from Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Chemische Technologie der Nuklearen Entsorgung. Available from Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Chemische Technologie der Nuklearen Entsorgung.

The reprocessing of irradiated fuel elements from a high-temperature reactor requires the separation of the fuel from the graphite matrix. This can be achieved by burning the graphite in a fluid-bed furnace. This process step was experimentally investigated using cold and hot spherical fuel elements. To this end, a fluidized bed combustion facility was set up in a hot cell with a fluidized bed reactor of 95 mm diameter and 1 m length. The maximum combustion rate was 1 kg graphite/h at a combustion temperature of 900 to 950deg C. Fine dust separation from the flue gas and above all recycling the dust to the fluidized reactor posed the greatest experimental problems. The best results for dust recycling were obtained by using an injector nozzle. BISO-coated UO_2 fuel kernels disintegrate into U_3O_8 dust during combustion. This leads to heavy-metal losses of up to 40% per combustion batch in a clean combustion unit due to the deposition of dust. The amount of heavy metal recovered increases by repeating the combustion process. An equilibrium in heavy-metal output was not achieved in hot tests. (orig.).

25514 (PNL-SA–17334) **The expected condition of spent LWR [light-water reactor] fuel on delivery to a repository.** Bailey, W.J.; Johnson, A.B. Jr. Pacific Northwest Lab., Richland, WA (USA). Dec 1989. 12p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. (CONF-900406–66: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009456. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The inventory of spent light-water reactor (LWR) fuel that is currently destined for disposal in a repository is steadily increasing. In the US, LWRs include boiling water reactors (BWRs) and pressurized water reactors (PWRs). A fuel assembly is normally comprised of fuel rods containing uranium oxide fuel pellets in Zircaloy cladding and nonfuel-bearing components, including spacer grids, end fittings, and water tubes in BWR fuel assemblies or control rod guide tubes in PWR fuel assemblies. The fuel cladding is the primary barrier preventing release of particulates of radioactive fuel and fission gases. Hence, integrity of fuel cladding is an important consideration in various stages of planning for spent fuel storage/transportation/disposal. Another consideration is the integrity of nonfuel-bearing components as failure of, or damage to, the components may complicate handling/storing/transporting/disposing of fuel assemblies. Regulation of spent fuel storage at US commercial LWRs and away-from-reactor facilities is addressed under 10 CFR 50^b and 10 CFR 72, respectively. 21 refs., 1 fig.

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Refer also to citation(s) 25508, 25509, 25604, 25754, 26378, 26382, 26384

25515 (CONF-880558–, pp. 147-155) **Compliance assessment of an uranium hexafluoride package 30B with overpack to the IAEA standards.** Andreuccetti, P. (PISA Univ. (Italy)); Aquaro, D.; Forasassi, G.; Beone, G.; Eletti, G.; Orsini, A. Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

At the Dipartimento di Costruzioni Meccaniche e Nucleari (DCMN) of the Pisa University a research program was carried out in order to assess the compliance to the updated IAEA standards of the UF6 30B container, complete with its sandwich phenolic foam filled external overpack. The research program, performed in collaboration with ENEA and several interested Italian firms, included 9 mt free drop, perforation, thermal and leaktightness tests, on two complete packages with dummy load. The heat transfer conditions, with the UF6 real contents, were simulated by means of numerical analyses with the TRUMP computer code and calculation procedures set up using the available experimental data. The attained results seem to be useful from the point of view of the foreseen purposes.

25516 (CONF-880558–, pp. 163-170) **Investigation of the thermal behavior of 2 1/2 ton cylinder protective overpack.** Park, S.H. (Oak Ridge National Lab., TN (USA)). Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

UF_6 cylinders containing reactor grade enriched uranium are transported in protective overpacks. Recently, the design of the 2 1/2 ton UF_6 cylinder overpack was modified to insure the safety of the cylinder inside the overpack. Modifications include a continuous stainless steel liner from the outer surface to the inner surface of the overpack and step joints between the upper and lower halves of the overpack. The effects of a continuous stainless steel liner and moisture in the insulation layer of a UF_6 cylinder protective overpack were investigated with a numerical code. Results were compared with limited available field data. The purpose of comparing the numerical results with field data is to insure the validity of the numerical analysis and the physical properties used in the analysis. The study indicates that the continuous stainless steel liner did not influence the heat transfer rate much from the outer surface of the overpack to the 30B cylinder inside. The effect of step joints was not modeled due to the difficulty of quantifying the leakage rate through the gap. With a continuous stainless steel liner from the outside of the overpack to the inside, the overpack satisfies the thermal design criteria of protecting the cylinder inside for a minimum of 30 minutes when the overpack is exposed to a fire. The effect of moisture inside the insulation layer in the overpack is to reduce the energy to the cylinder with its high thermal capacity. The high pressure steam generated from the moisture will be relieved externally through the vent holes on the outer surface

of the overpack. Although these holes are sealed after the overpack is dried, the plug sealing the holes will melt when the overpack is exposed to a fire.

25517 (CONF-880558–, pp. 187) **The IAEA recommendations for providing protection during the transport of uranium hexafluoride.** Levin, I. (International Atomic Energy Agency, Vienna (Austria)); Wieser, K. Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

The Regulations for the safe transport of radioactive materials, are the basis of national and international regulations concerning this subject throughout the world. These regulations require that subsidiary hazards associated with radioactive materials should also be considered. Other national and international regulations concerning the transport of dangerous materials consider that a radioactive material having other dangerous properties should be classified as class 7. Following this line and acting upon the recommendations of SAGSTRAM (Standing Advisory Committee on the Safe Transport of Radioactive Materials) that the Agency should take the lead in providing guidance to Member States with respect to UF_6 packaging and transport, the Agency convened two expert meetings during 1986 and 1987 in order to look into the special problems associated with the transport of uranium hexafluoride. The experts identified several areas in which additional safety measures should be considered if the transport of UF_6 is to have a non-radiological safety level consistent with that of its radiological risks. In this presentation the new recommendations are described. The main safety issues to be discussed are fire resistance, valve protection and compatibility with service and structural equipment. Another aspect of importance is the interface between the process and the transport phases, bearing in mind that the same containers are used in both. This paper also reveals how far the new recommendations concerning UF_6 have already been endorsed in the forthcoming European Transport Regulations (ADR/RID) together with the 1985 revised Edition of IAEA Safety Series No. 6.

25518 (CONF-880558–, pp. 197-199) **The cleaning of uranium hexafluoride cylinders containing residual quantities of uranium hexafluoride and impurities.** Davis, W.M. (Allied-Signal, Inc., Metropolis, IL (USA)); Huffman, D.S. Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

There is a need to clean cylinders which have contained natural uranium in the form of uranium hexafluoride at the Metropolis, Illinois plant of Allied-Signal, Inc. The intent of the cleaning procedure is to neutralize and remove residual UF_6 and nonvolatile impurities and daughter products which accumulate over a period of time. It should be emphasized that this procedure is applicable to cylinders which have been used to contain only natural uranium and in which the residual material totals less than fifty pounds. The cleaning procedure is begun by connecting the cylinder to a vacuum source which is supplied by circulating a sodium carbonate wash solution through an eductor. After the UF_6 fumes have been removed from the cylinder is sprayed with the wash solution which is maintained at an appropriate pH to solubilize the uranium. The pressure in the cylinder is carefully regulated during the chemical reaction phase of the cleaning procedure. After the washing has been completed, the contents are drained from the cylinder, and the cylinder is rinsed with water. The sodium carbonate solution is filtered and then processed for the recovery of uranium. The insoluble material containing the daughter products is removed by the filtration.

25519 (CONF-880558–, pp. 133-139) **Thermal behavior of the type 30B cylinder equipped with the 21PF.1 overpack and study of protective covers for the 48Y cylinder valve.** Warniez, P. (CEA - IPSN, Fontenay (France)); Ringot, C.; Perrot, J.; Bernard, H. Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

This paper describes the tests which have been performed in France: first to verify the behavior of 30B cylinders with their 21PF.1 protective overpack, and secondly to develop a better mechanical protection of the valve. The thermal tests have been performed on real packagings filled with UF_6, after the mechanical AIEA tests (free drop 9 m and 1 m on a pitch). A methodical approach has been used with large thermal instrumentation: tests with inert material, transposition by calculation of the results of the case of UF_6 filling, confirmation tests with UF_6. The results were very satisfactory, the maximal temperatures which were measured on the external overpack of the 30B cylinder being much lower than the filling temperature. In the Mont Louis wreckage, some of the valves of 48Y cylinders were damaged, as a consequence of the displacement of the protecting cover, and two of them were so damaged as to enable water to enter the cylinder. A new valve protector was designed and was tested under impact situations. The test programme was preformed with the two designs: the standard one the new protecting covers. The tests have demonstrated that the new design which has the same weight as the original one the and which may be used without any modifications of the cylinder, has a better behavior, increasing the safety during transport.

25520 (CONF-880558–, pp. 141-146) **Need for improved UF_6 handling and transportation practices.** Kovac, F.M. (Martin Marietta Energy Systems, Inc., Piketon, OH (USA)). Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

Rigid design requirements for enriched uranium hexafluoride (UF_6) cylinder protective structural packages PSPs or simply overpacks have contributed to the nuclear industry achieving greater than 30 years of operating experience with no transportation-related accidents resulting in the release of UF_6. However due to aging and continued over-the-road use, it is questionable whether all overpacks still meet the specifications to which they were manufactured. Overpacks are certified by their owners to be in conformance with U.S. Department of Energy (USDOE) ORO-651 and ANSI N 14.1 specifications; however, inspections often reveal this is not the case. Overpack maintenance seems to be done infrequently or not at all. UF_6 shipments from Portsmouth are not made until the existing regulations governing overpacks, tie-downs and the condition of trailers are satisfied. In numerous cases this has resulted in changing the initial shipment schedule. Inasmuch as industry standards must be met, and the overpacks are not always given necessary maintenance, the need exists for more frequent inspections and routine maintenance.

25521 (CONF-880558–, pp. 157-159) **Update on packaging for uranium hexafluoride transport.** Pryor, W.A. (Department of Energy, Oak Ridge, TN (USA)). Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

The slightly enriched product UF_6 shipped from the enriching plants for the world's nuclear power plants must be protected in order to conform to domestic and international transport regulations. The principal overpack currently in use is the U.S. Department of Transportation (DOT) Specification 21PF-1 which protects Model 30 UF_6 cylinders (Title 49, Code of Federal Regulations; Part 178.121, Specification 21PF-1; Fire and Shock Resistant, Phenolic - Foam Insulated Overpack [Horizontal Loading]). Operational problems have developed due both to design and lack of maintenance, resulting in the entry of water into the insulation zone. Following major review of these problems, particularly those concerned with water entry and general deterioration, design modifications for have been proposed. These modifications for existing overpacks are to be made only after any water absorbed within the phenolic foam

insulation is reduced to an acceptable level. New overpacks will be fabricated under an enhanced design. Existing overpacks which are modified will be designated as 21PF-1A while new overpacks fabricated to the enhance design will be designated as 21PF-1B. In both cases, proposed quality assurance/control requirements in the fabrication, modification, use and maintenance of the overpacks are applicable to fabricators, modifiers, owners and users. A composite report describing the proposal has been prepared.

25522 (CONF-880558–, pp. 161-162) **Thermal properties evaluation of UF_6 cylinder overpack insulation.** Frazier, J.L. (Martin Marietta Energy System, Inc., Oak Ridge, TN (USA)). Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

A phenolic foam is incorporated into the design and construction of UF_6 cylinder shipping containers known as overpacks. The overpack provides mechanical and thermal protection of UF_6 product cylinders during transport. The phenolic foam is utilized for thermal insulation. An important criterion in overpack design is to limit temperature excursions of the product cylinder below the triple point of UF_6, preventing possible overpressurization of the cylinder. A current requirement is that the product cylinder wall temperature be maintained below the UF_6 triple point with the outer surfaces of the overpack exposed to 1475 F for thirty minutes. A possible heat source is the close proximity of a fire. Overpack thermal protection design requires thermal properties data for the materials of construction, particularly for the phenolic foam insulation which provides the primary thermal resistance. Thermal conductivity and heat capacity data for the phenolic foam are limited in the literature. Accurate heat transfer models of the overpack require thermal properties spanning the range from room temperature to 1475 F. An experimental program was devised to measure the thermal conductivity and heat capacity of the insulating foam over the temperature span of interest.

25523 (CONF-880558–, pp. 171-177) **One-inch UF_6 cylinder valve failure.** Blue, S.C. (Martin Marietta Energy Systems, Inc., Paducah, KY (USA)); Alderson, J.H. Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

Defects in one-inch cylinder valves procured for use in uranium hexafluoride (UF_6) cylinders were discovered during installation. The defects were detected by soap testing of the valves and cylinders. The investigation detected similar problems in other production runs by the same manufacturer. This paper covers the investigation of the original problem, evaluation of the defects, notification of all concerned parties, interim solution, and corrective actions taken to eliminate this problem.

25524 (CONF-880558–, pp. 179-182) **Testing of UF_6 pigtails.** Dorning, R.E. (Martin Marietta Energy Systems, Inc., Piketon, OH (USA)). Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

The transfer of UF_6 and other hazardous materials between cylinders and manifolds requires the use of pigtails - flexible couplings which allow for misalignment between those parts of the transfer system while providing the required containment of material. To ensure reliability of materials and designs, a UF_6 pigtail test facility was designed and fabricated at the Portsmouth Gaseous Diffusion Plant. This test facility is capable of accommodating the broad ranges of variables found in actual usage. A test is performed by rotating one end of a pressurized pigtail in a circular pattern at the design flexibility requirement until a decrease in operating pressure is detected which denotes failure. Test of pigtails has been most beneficial in identifying deficiencies in design, fabrication, and materials of construction. This paper discusses the testing and results of twenty pigtail designs. The resultant uniform fabrication procedures, along with improved inspection methods, have produced safer and more reliable designs.

25525 (CONF-880558–, pp. 183-186) **Safe transport of UF-6 in the private sector, 1967-1988.** Jody, B. Jr. Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

This paper examined the ingredients of what the author has come to call an engineered transport system. The ongoing series of discussions, periods of construction, testing of equipment and the never ending training of personnel have long since welded themselves into a single entity with one purpose, the delivery of UF-6 and other nuclear materials safely, quietly and efficiently. At this point the company has moved some 750,000,000 pounds of UF-6 without accident or incident. An engineered motor transport system (E.M.T.) is one in which the equipment has been built to handle the specific loads which it will carry. The E.M.T. system incorporates the personnel of the carrier, the equipment manufacturer, and the shipper in the final decision to submit the end project to the road. Everyone is responsible for its success. An E.M.T. system is durable, survivable, defensible, and insurable.

25526 (CONF-880558–, pp. 191-195) **The regulations and the problems of their implementation in UF_6 transport.** Deviillers, C. (CEA - IPSN, Fontenay (France)); Grenier, M.; Ringot, C.; Warniez, P.; Blum, P. Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

UF_6 is currently transported in packagings which were developed in the sixties - standardized and used all over the world. In the absence of significant releases during the great number of shipments carried out until now by all modes of transport, even after accidents, one must recognize that these packagings perform their duty adequately. Nevertheless, one must be aware that the growing amounts of UF_6 issued from URT and the changes in the regulations now raises the problem of compliance of these packagings with the latter. Among the problems which deserve special attention, the following are particularly noteworthy: selection of the packaging type (Industrial, A or B type; fissile or non fissile) in terms of the origin and the enrichment of the UF_6, design of valve covers (mechanical protection, leakage barrier, criticality control), regulatory requirements in handling, typing down cleaning and unloading, allowable dose rate increase in case of minor mishaps, behavior in fire, taking into account the toxicity of UF_6, identification of special features required in the case of controlled moderation of fissile packages, and transport conditions of empty packagings containing heels. (LAS or not, allowance of transport without protective packagings). It seems that most of these points are purely formal and will be easily solved by amendments to the regulations while others are specific to the nature of UF_6. It seems also that the desirable modifications to the existing transport packagings are relatively minor, a consensus being necessary on the working conditions.

25527 (CONF-880558–, pp. 201-207) **Cleaning and inspection experience of UF_6 30B cylinders.** Watanabe, Tsuneo (Mitsubishi Nuclear Fuel Co., Ltd., Ibaraki-Ken (Japan)); Nakabayashi, Tetsuo; Kamei Yoshinobu. Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

Operational experience on cleaning and inspection of UF_6 30B cylinders started in 1985 is described. Cleaning results show that surface radiation rate of cylinders ranging from 1 μSv (0.1 mrem) ~ 0.7 mSv (70 mrem) per hour before washing is reduced to 0.2

μSv (0.02 mrem) ~ 1.5 uSv (0.15 mrem) per hour after washing. Average weight of wet precipitate containing uranium is less than 3 kg per cylinder, which are higher than originally expected. This precipitate is put into polyethylene packs, which contain some 3 kg per pack in average and whose surface radiation dose rate ranges from 0.07 mSv (7 mrem) to 0.85 mSv (85 mrem) per hour. The average amount of process liquid waste is approximately 0.6 m^3 per cylinder, and after treatment its α and β radioactivity become $<7.4 \times 10^{-3}$ Bq (2×10^{-7} μCi)/cm^3 (α) and $<1.1 \times 10^{-1}$ Bq (3×10^{-6} μCi)/cm^3 (β) respectively. Radiation control results such as personnel dose rate, airborne concentration in the restricted area and that of gaseous effluent from the stack and so on are also presented. The radiation dose rate of the operators is very low in both whole body dose and skin dose.

25528 (CONF-880558–, pp. 235-237) **Uranium hexafluoride - emergency preparedness improvements.** Windt, N.F. (Paducah Gaseous Diffusion Plant, KY (USA)). Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

The United States Enrichment Enterprise has successfully handled uranium hexafluoride (UF_6) for almost 40 years. However, recent events and legislation have accelerated and emphasized the role of Emergency preparedness. This paper briefly describes several recent improvements in the planning/training, installation of new equipment, and public communications areas to further reduce the hazard potential of UF_6. The improvements discussed are being implemented at the Department of Energy's (DOE) Gaseous Diffusion Plant, located at Paducah, Kentucky and operated by Martin Marietta Energy System, Inc. The paper is organized into three major areas: Planning/Training, New Equipment, and Public Communication. The paper is designed as a collection of several emergency preparedness items. The brief review of these items should stimulate follow-up by interested parties. Some of the planning/training items discussed are emergency squads and their training, the use of drills, tabletop exercises, emergency operations simulations, and full-scale field exercises utilizing mutual aid. Installation of new equipment will include the latest in impermeable suits and respiratory protection equipment, public warning systems, CO_2 systems, cylinder patch kits, meteorological stations, TV monitors, and other emergency operating center improvements. The public relations section discusses the implications of installing a public warning system, involvement in local planning committees (SARA-III), and the use of a Joint Public Information Center (JPIC).

25529 (CONF-880558–, pp. 209-214) **UF_6 cylinder washing at ANF [Advanced Nuclear Fuels].** Keith, W.G. Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

Advanced Nuclear Fuels (ANF) Corporation receives UF6 cylinders in its Richland, WA fuel fabrication plant from its utility customers. Following transfer of the UF6, designated cylinders are cleaned by washing using a specialized process which emphasizes personnel safety and low cost. The cleaning operation is conducted in accordance with the guidelines is conducted in accordance with the guidelines of ANSI Standard N14.1. Specialized equipment has been developed for carrying out this operation with a minimum of space and manpower. Equipment designs and process methods are selected to ensure that the cylinders meet cleanliness requirements while maintaining low personnel radiation exposures, avoiding introduction of organic material and achieving low applied labor. A photo tour is used to illustrate the equipment and methods used.

25530 (CONF-880558–, pp. 221-225) **COGEMA's UMF [Uranium Management Facility].** Lamoriette, G.; Bertrand, J.P. Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

The French government-owned corporation, COGEMA, is responsible for the nuclear fuel cycle. This paper describes the activities at COGEMA's Pierrelatte facility, especially its Uranium Management Facility. UF6 handling and storage is described for natural, enriched, depleted, and reprocessed uranium. UF6 quality control specifications, sampling, and analysis (halocarbon and volatile fluorides, isotopic analysis, uranium assay, and impurities) are described. In addition, the paper discusses the filling and cleaning of containers and security at UMF.

25531 (EPRI-NP–6722) **Fuel consolidation demonstration: Consolidation concept development.** Electric Power Research Inst., Palo Alto, CA (USA); Combustion Engineering, Inc., Windsor, CT (USA); Northeast Utilities Service Co., Berlin, CT (USA). c Feb 1990. 109p. Sponsored by U.S. DOE Radioactive Waste Management; Electric Power Research Institute. DOE Contract AC06-76RL01830. (PNL–7172). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

EPRI, Northeast utilities Service Company (NUSCO), DOE, Baltimore Gas & Electric Company, and Combustion Engineering, Inc. (C-E) are engaged in a program to develop a system for consolidating spent fuel, in which the consolidated fuel will be licensable by NRC for storage in the spent-fuel storage pool. Fuel consolidation offers a means of substantially increasing the capacity of spent-fuel storage pools. Consolidation equipment design, development, construction, and testing are being performed by C-E in Windsor, Connecticut. Seismic and structural evaluation of the capability of the Millstone Unit 2 spent-fuel pool and building to accommodate the increased fuel capacity is being conducted by NUSCO. NUSCO plans to obtain a license to store consolidated fuel in the Millstone-2 spent-fuel storage pool. NUSCO also plans to perform a hot demonstration of the integrated consolidation system with spent fuel at Millstone-2. This report describes the consolidation system design that forms the basis for the detailed design of the equipment comprising the system, including information on the fabrication and testing of the equipment. Appendix B describes an evaluation of the ability of the system under development to consolidate LWR spent-fuel assemblies other than the 14 x 14 fuel of C-E design stored at Millstone-2. A comparison was made of fuel-assembly designs on the basis of information available in open literature. It was concluded that with appropriate dimensional modifications the spent-fuel consolidation system equipment design is applicable to almost all PWR fuel-assembly configurations. 8 refs., 20 figs.

25532 (KAERI/AR–300/88) **An analysis of heating, ventilation and air conditioning system for nuclear facilities.** Park, Hyun Soo (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Kim, Byung Tae; Park, Seong Won; Cho, Soo Haeng; Lee, Yong Rae; Lee, Kyung Ku; Park, Seung Hyub; Hwang, Jeong Ki; Kim, Jeong Mook; Oh, Haeng Yoeb. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 65p. (In Korean). Order Number DE90623216. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

An analysis of HVAC system was made on various nuclear facilities such as the existing nuclear power plants in Korea, Post Irradiation Examination Facility at KAERI and Midwest Fuel Recovery Plant in USA, to get basic data and information for the design of the spent fuel interim storage facility to be implemented as one of the radwaste management projects. With the results of this study, the HVAC system to be applied to the spent fuel interim storage facility was selected and the major design considerations of the facility were suggested. (Author).

25533 (KAERI/AR–301/88) **The state-of-the-art report on IAEA safeguards of spent fuel storage facilities.** Park, Hyun Soo (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Kim, Byung Tae; Park, Seong Won; Cho, Soo Haeng; Lee, Yong Rae; Lee, Kyung Ku; Park, Seung Hyub; Hwang, Jeong Ki; Kim, Jeong Mook; Oh, Haeng Yeob. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 63p. (In Korean). Order Number DE90623217. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The objectives of this report are to investigate the procedures and detection target for the safeguards system of spent fuel storage, and to analyze the status of the international safeguards for spent fuel storage facilities. Safeguards for spent fuel storage are being implemented in accordance with the IAEA statute and two fundamental agreements (INFCIRC/66/Rev.2 and INFCIRC/153). IAEA safeguards for spent fuel storage are based on item accounting procedures, which include item counting and identification, and non-destructive measurement. Analysis shows that IAEA safeguards for wet interim storage have few problems because of the accumulated similar experiences in wet storage at reactors and reprocessing plants, but those for dry interim storage have much more complicated problems and require strict containment and surveillance measures because the on-storing inspection of spent fuel is nearly impossible. (Author).

25534 (KAERI/RR–744/88) **Study on the behavior of the defected light water reactor fuel in wet storage.** Ro, Seung Gy (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Kim, Eun Ka; Park, Chong Mook; Hong, Gye Won; Chun, Young Bum; Ji, Pyeong Guk; Lee, Young Joo; Kim, Young Soo. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 51p. (In Korean). Order Number DE90623218. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

To study the effect of the defected fuel rods on the spent fuel storage pool , ten intact fuel rods were selected from a PWR spent fuel assembly which experienced the average discharge burnup of 35,000 MWD/MTD and has been cooled for 5 years. Artificial defects on the fuel rod clad were machined in hot cell and then examined non-destructively before in-pool storage, and the defected rods were separately stored in closed and open container tubes. Water in the storage pool and fuel rod container tubes has been periodically sampled and analyzed. The radioactive materials detected were Co-60, Cs-134 and Cs-137. The Co-60 was slowly and linearly released, and its release rate was different from rod to rod. The obtained average release rate of the Co-60 was about 1x10E-5μCi/ml.day. The Cs-134 and Cs-137 were rapidly released over the first 30 days of storage and then slowly released, and their extents of release rates seemed to be affected by the shape of defect. The average release rates after 30 days of storage were 8.5 and 1.6 μCi/ml.day for Cs-134 and Cs-137, respectively. (Author).

0510 Economic, Industrial, and Business Aspects

Refer also to citation(s) 25601

0520 Waste Management

Refer also to citation(s) 25531, 25532, 25533, 25601, 25607, 25609, 25610, 25783, 25909, 26076, 26300, 26558, 26781, 26839, 26841, 27135, 27146, 27147, 27148, 27149, 27150, 27151, 27152, 27153, 27154, 27155, 27156, 27157, 27158, 27159, 27160, 27161, 27162, 27163, 27164, 27165, 27166, 27167, 27168, 27169, 27170, 27171, 27172, 27173, 27174, 27175, 27177, 27178, 27179, 27180, 27181, 27182, 27183, 27186

25535 (AD-A–215831/9/XAB) **Reference properties of cement-based plugging and sealing materials for the Waste Isolation Pilot Plant (WIPP). Final report.** Gulick, C.W.; Wakeley, L.D. Army Engineer Waterways Experiment Station, Vicksburg, MS (USA). Structures Lab. Nov 1989. 20p. (WES/TR/SL–89-17). Available from NTIS, PC A03/MF A01.

The Structures Laboratory of the US Army Engineer Waterways Experiment Station has conducted research on cement-based composites for the Waste Isolation Pilot Project (WIPP) since 1977 in support of Sandia National Laboratories. Sealing shafts and plugging boreholes for closure of this geologic repository for radioactive wastes will require grouts and concretes. Salt-saturated grouts and concretes bond adequately to the bedded halite host rock. Freshwater mixtures will plug and seal penetrations through nonhalite strata. This report gives reference values for such properties as unconfined compressive strength, static modulus, restrained expansion, and permeability of candiate grouts and concretes. Values tabulated here are not averages but are values that one could reasonably expect to attain with other candiate mixtures of similar composition. They are values that the authors consider reasonable targets for cement-based composites likely to be used in the closure phase of operation of the WIPP or other underground repository.

25536 (BMI/ONWI–354) **Archaeological data as a basis for repository marker design.** Kaplan, M.F. Analytic Sciences Corp., Reading, MA (USA). Oct 1982. 92p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. Available from OSTI; INIS.

This report concerns the development of a marking system for a nuclear waste repository which is very likely to survive for 10,000 years. In order to provide a background on the subject, and for the preliminary design presented in this report, a discussion is presented about the issues involved in human interference with the repository system and the communication of information. A separate chapter summarizes six ancient man-made monuments including: materials, effects of associated textual information on our understanding of the monument, and other features of the ancient monument relevant to marking a repository site. The information presented in the two chapters is used to provide the basis and rationale for a preliminary marker system design presented in a final chapter. 86 refs., 22 figs., 1 tab.

25537 (CEA-CONF–9889) **Dismantling of an alpha contaminated hot cell at the Marcoule Pilot Plant.** Tachon, M. CEA Etablissement de la Vallee du Rhone, 30 - Bagnols-sur-Ceze (France). 1988. 15p. (In French). (CONF-8810305–: 15. Meeting of the Association pour les Techniques et les Sciences de Radioprotection on Dismantling of Nuclear Plants, Wastes and Associated Problems of Radiation Protection, Grenoble (France), 5-7 Oct 1988). Order Number DE90762060. Available from NTIS (US Sales Only), PC A03/MF A01.

For the remodeling of Marcoule Pilot Plant, the cell 82: old unit for plutonium solution purification by extraction, was dismantled. About 42 tons of wastes were evacuated. Some wastes wen decontaminated by mechanical means other wastes with higher residual activity were stored for subsequent processing. The operation shows that dismantling of a hot cell is possible even if incorporated in an operating plant.

25538 (CEGB-RD-B–6181/R89) **MIND - group formulation of a collaborative technical programme.** McCabe, A.M. (ed.). Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. Mar 1989. 83p. Order Number DE90620400. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The proceedings of the 2nd meeting of the Microbiology in Nuclear Waste Disposal (MIND) are reviewed. It has been recognised that microbiological effects may be significant in many radioactive waste repository types and may play a major role in some disposal concepts. The present state of research in this field and funding for it was reviewed at the meeting. The particular research areas discussed were microbial transport processes and near and far-field processes. Methodologies were discussed, recognising the wide gulf which exists between chemists and microbiologists in their approach to waste disposal. A list of emphases for future work within the MIND group arising out of current research was drawn up. The Appendices include a paper on the interactions of metal ions with components of bacterial cell walls and their biomineralisation; and another on the potential effects of microorganisms on trace element transport. (UK).

25539 **Scientific basis for nuclear waste management 12.** Materials Research Society symposium proceedings; Volume 127. Lutze, W. (Hahn-Meitner-Institut Berlin GmbH (Germany, F.R.)); Ewing, R.C. (eds.). 1001p. Materials Research Society, Pittsburgh, PA (USA) (1989). Sponsored by U.S. DOE Nuclear Energy. DOE Contract FG03-88SF17897. From 12. international symposium on the scientific basis for nuclear waste management; Berlin (Germany, F.R.); 10-13 Oct 1988.

The Twelfth International Symposium on the Scientific Basis for Nuclear Waste Management was held in Berlin, Germany, on October 10–13, 1988. The principal topics addressed in this meeting included: (1) glass and crystalline materials; (2) spent fuel; (3) corrosion of canister and overpack materials; (4) cement waste forms and bitumen; (5) repositories; (6) reactions and transport of

radionuclides and of water-speciation. This volume contains 123 papers. Individual papers are processed separately on the data bases. (KD)

25540 (DOE/HWP–95) **Proceedings of the US Department of Energy Office of Defense Programs waste reduction workshop 3.** Oak Ridge National Lab., TN (USA). Hazwrap Support Contractor Office. Feb 1990. 253p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OT21400. (CONF-8908154–Summ.: 3. waste reduction workshop, Burlingame, CA (USA), 29-30 Aug 1989). Order Number DE90009223. Available from NTIS, PC A12/MF A01 - OSTI.

The third of a series of waste minimization/reduction workshops was held at the Amfac Hotel in Burlingame, California, on August 29 to 30, 1989. The purpose of the workshops is to assist Department of Energy (DOE) waste-generating sites in implementing waste minimization/reduction programs, plans, and activities, thus providing for optimal waste reduction within the DOE complex. All wastes are considered within this discipline: liquid, solid, and airborne, within the categories of high-level (HLW), transuranic (TRU), low-level (LLW), hazardous, and mixed. Topics of discussion within workshops encompass a wide range of subjects. Subjects include any method or technical activity from waste generation to disposal, such as process design or improvement, substitution of materials, waste segregation and recycling/reuse, waste treatment and processing, and administrative controls (procurement and waste awareness training). Consideration is also given to activities for remedial action and for decontamination and disposal.

25541 (DOE/ID/12648–T1) **Preliminary design report for prototypical spent nuclear fuel rod consolidation equipment.** Judson, B.F.; Maillet, J.; O'Neill, G.L.; Tsitsichvili, J.; Tucoulat, D. General Electric Co., San Jose, CA (USA). Dec 1986. 342p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC07-86ID12648. (GEFR–00800). Order Number DE90008782. Available from NTIS, PC A15/MF A01; OSTI; INIS.

The purpose of the Prototypical Consolidation Demonstration Project (PCDP) is to develop and demonstrate the equipment system that will be used to consolidate the bulk of the spent nuclear fuel generated in the United States prior to its placement in a geological repository. The equipment must thus be capable of operating on a routine production basis over a long period of time with stringent requirements for safety, reliability, productivity and cost-effectiveness. Four phases are planned for the PCDP. Phase 1 is the Preliminary Design of generic consolidation equipment that could be installed at a Monitored Retrievable Storage (MRS) facility or in the Receiving & Handling Facility at a geologic repository site. Phase 2 will be the Final Design and preparation of procurement packages for the equipment in a configuration capable of being installed and tested in a special enclosure within the TAN Hot Shop at DOE's Idaho National Engineering Laboratory. In Phase 3 the equipment will be fabricated and then tested with mock fuel elements in a contractor's facility. Finally, in Phase 4 the equipment will be moved to the TAN facility for demonstration operation with irradiated spent fuel elements. 55 figs., 15 tabs.

25542 (DOE/IG–0280) **Followup review of fees paid by the civilian power industry to the Nuclear Waste Fund.** USDOE Office of Inspector General, Washington, DC (USA). Capital Regional Office. 26 Mar 1990. 11p. Sponsored by U.S. DOE Office of Inspector General. Available from OSTI.

Report to The Secretary.

The subject report is being provided to inform you of our finding and recommendation and to give you an opportunity to comment. The Nuclear Waste Policy Act of 1982 stipulates that the costs of the waste disposal program, which was established to implement safe disposal of civilian-owned nuclear waste generated by nuclear power plants, are to be borne by the utilities through payment of fees into the Nuclear Waste Fund.

25543 (DOE/OR/21548–094-Rev.2) **WSSRAP [Weldon Spring Site Remedial Action Project] quarry preliminary engineering report: Revision 2.** MK-Ferguson Co., St. Charles, MO (USA); Jacobs Engineering Group, Inc., St. Charles, MO (USA). Jan 1990. 122p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-86OR21548. Order Number DE90009205. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

The removal, transport, and temporary storage of radiologically and chemically contaminated bulk waste from the Weldon Spring Quarry will be accomplished by dividing the work into three subcontract packages. The major portion of the work will come under the bulk waste excavation package; construction of a temporary storage area (TSA) at the Weldon Spring Chemical Plant and of a haul road between the quarry and the TSA comprise the other two packages. Cost estimates to complete the removal range from $5 million to $9.4 million due to a high degree of uncertainty regarding both the productivity of the excavating equipment and the effectiveness of planned dewatering efforts. Quarry wastes will be substantially dewatered and the water treated before discharge. Waste will be excavated in three phases, using conventional construction equipment, with preliminary sorting of waste at the quarry before transport to the TSA. Special attention will be given to controlling the spread of contamination by careful monitoring and control of surface and groundwater drainage and of particulate and radiological contamination of the air. 6 refs., 21 figs., 8 tabs.

25544 (DOE/RL–88-27-Vol.1-Rev.1) **Grout Treatment Facility dangerous waste permit application: Volume 1, Revision 1.** USDOE Richland Operations Office, WA (USA). 17 Jan 1990. 501p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90009098. Available from NTIS, PC A22/MF A01 - OSTI; GPO Dep.

This chapter briefly describes the Hanford Site, provides a general description of the Site operations and administration, provides an overview of the contents of this Grout Treatment Facility (GTF) Dangerous Waste permit application, and gives a list of acronyms and abbreviations used in this document. The GTF is a waste management unit within the Hanford Site. In May 1988, an amended Part A permit application was filed that identified the GTF as an existing facility. In addition to the design and operating features of the GTF that are intended to meet the requirements of dangerous waste regulations, many additional design and operating features are necessary to comply with radioactive waste management practices. The GTF design features and practices are intended to keep operational exposure to radionuclides and dangerous substances 'as low as reasonably achievable' (ALARA) and to provide a disposal system that protects the environment for at least 10,000 yr. In some instances, ALARA practices present difficulties when complying with requirements of dangerous waste regulations. These difficulties are identified in the document, and methods of resolving them are proposed. The primary consideration is prevention of exposure to radiation. However, prevention of radiation exposure also reduces the possibility of releases of dangerous wastes that could affect human health or the environment.

25545 (DOE/RL–88-27-Vol.2-Rev.1) **Grout Treatment Facility dangerous waste permit application: Volume 2, Revision 1.** USDOE Richland Operations Office, WA (USA). 17 Jan 1990. 446p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90009099. Available from NTIS, PC A19/MF A01 - OSTI.

This chapter briefly describes the Hanford Site, provides a general description of the Site operations and administration, provides an overview of the contents of this Grout Treatment Facility (GTF) Dangerous Waste permit application, and gives a list of acronyms and abbreviations used in this document. The GTF is a waste management unit within the Hanford Site. In May 1988, an amended Part A permit application was filed that identified the GTF as an existing facility. In addition to the design and operating features of the GTF that are intended to meet the requirements of dangerous waste regulations, many additional design and operating features are necessary to comply with radioactive waste management practices. The GTF design features and practices are intended to keep operational exposure to radionuclides and dangerous substances 'as low as reasonably achievable' (ALARA) and to provide a disposal system that protects the environment for at least 10,000 yr. In some instances, ALARA practices present difficulties when complying with requirements of dangerous waste regulations. These difficulties are identified in the document, and methods of resolving them are proposed. The primary consideration is prevention of exposure to radiation. However, prevention of

radiation exposure also reduces the possibility of releases of dangerous wastes that could affect human health or the environment. This volume contains 13 appendices. Topics include engineering drawings, maps, roads, toxicity testing, and pilot-scale testing.

25546 (DOE/RL–88-27-Vol.3-Rev.1) **Grout Treatment Facility dangerous waste permit application: Volume 3, Revision 1.** USDOE Richland Operations Office, WA (USA). 17 Jan 1990. 569p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90009100. Available from NTIS, PC A24/MF A01 - OSTI.

This chapter briefly describes the Hanford Site, provides a general description of the Site operations and administration, provides an overview of the contents of this Grout Treatment Facility (GTF) Dangerous Waste permit application, and gives a list of acronyms and abbreviations used in this document. The GTF is a waste management unit within the Hanford Site. In May 1988, an amended Part A permit application was filed that identified the GTF as an existing facility. In addition to the design and operating features of the GTF that are intended to meet the requirements of dangerous waste regulations, many additional design and operating features are necessary to comply with radioactive waste management practices. The GTF design features and practices are intended to keep operational exposure to radionuclides and dangerous substances 'as low as reasonably achievable' (ALARA) and to provide a disposal system that protects the environment for at least 10,000 yr. In some instances, ALARA practices present difficulties when complying with requirements of dangerous waste regulations. These difficulties are identified in the document, and methods of resolving them are proposed. The primary consideration is prevention of exposure to radiation. However, prevention of radiation exposure also reduces the possibility of releases of dangerous wastes that could affect human health or the environment. This volume contains 5 appendices covering pilot-scale testing. Supernatant sampling, laboratory procedures, waste composition verification, and engineering drawings.

25547 (DOE/RL–88-27-Vol.4-Rev.1) **Grout Treatment Facility dangerous waste permit application: Volume 4, Revision 1.** USDOE Richland Operations Office, WA (USA). 17 Jan 1990. 443p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90009101. Available from NTIS, PC A19/MF A01 - OSTI.

This chapter briefly describes the Hanford Site, provides a general description of the Site operations and administration, provides an overview of the contents of this Grout Treatment Facility (GTF) Dangerous Waste permit application, and gives a list of acronyms and abbreviations used in this document. The GTF is a waste management unit within the Hanford Site. In May 1988, an amended Part A permit application was filed that identified the GTF as an existing facility. In addition to the design and operating features of the GTF that are intended to meet the requirements of dangerous waste regulations, many additional design and operating features are necessary to comply with radioactive waste management practices. The GTF design features and practices are intended to keep operational exposure to radionuclides and dangerous substances 'as low as reasonably achievable' (ALARA) and to provide a disposal system that protects the environment for at least 10,000 yr. In some instances, ALARA practices present difficulties when complying with requirements of dangerous waste regulations. These difficulties are identified in the document, and methods of resolving them are proposed. The primary consideration is prevention of exposure to radiation. However, prevention of radiation exposure also reduces the possibility of releases of dangerous wastes that could affect human health or the environment. This volume contains 2 appendices covering engineering drawings and operating procedures.

25548 (DOE/RL–88-27-Vol.5-Rev.1) **Grout Treatment Facility dangerous waste permit application: Volume 5, Revision 1.** USDOE Richland Operations Office, WA (USA). 17 Jan 1990. 1331p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90009102. Available from NTIS, PC A99/MF A01 - OSTI.

This chapter briefly describes the Hanford Site, provides a general description of the Site operations and administration, provides an overview of the contents of this Grout Treatment Facility (GTF) Dangerous Waste permit application, and gives a list of acronyms and abbreviations used in this document. The GTF is a waste management unit within the Hanford Site. In May 1988, an amended Part A permit application was filed that identified the GTF as an existing facility. In addition to the design and operating features of the GTF that are intended to meet the requirements of dangerous waste regulations, many additional design and operating features are necessary to comply with radioactive waste management practices. The GTF design features and practices are intended to keep operational exposure to radionuclides and dangerous substances 'as low a reasonably achievable' (ALARA) and to provide a disposal system that protects the environment for at least 10,000 yr. In some instances, ALARA practices present difficulties when complying with requirements of dangerous waste regulations. These difficulties are identified in the document, and methods of resolving them are proposed. The primary consideration is prevention of exposure to radiation. However, prevention of radiation exposure also reduces the possibility of releases of dangerous wastes that could affect human health or the environment. This volume contains 7 appendices covering transportable equipment, instruments, compatibility testing, design and vendor information.

25549 (DOE/RL–88-27-Vol.6-Rev.1) **Grout Treatment Facility dangerous waste permit application: Volume 6, Revision 1.** USDOE Richland Operations Office, WA (USA). 17 Jan 1990. 661p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90009103. Available from NTIS, PC A99/MF A01 - OSTI.

This chapter briefly describes the Hanford Site, provides a general description of the Site operations and administration, provides an overview of the contents of this Grout Treatment Facility (GTF) Dangerous Waste permit application, and gives a list of acronyms and abbreviations used in this document. The GTF is a waste management unit within the Hanford Site. In May 1988, an amended Part A permit application was filed that identified the GTF as an existing facility. In addition to the design and operating features of the GTF that are intended to meet the requirements of dangerous waste regulations, many additional design and operating features are necessary to comply with radioactive waste management practices. The GTF design features and practices are intended to keep operational exposure to radionuclides and dangerous substances 'as low as reasonably achievable' (ALARA) and to provide a disposal system that protects the environment for at least 10,000 yr. In some instances, ALARA practices present difficulties when complying with requirements of dangerous waste regulations. These difficulties are identified in the document, and methods of resolving them are proposed. The primary consideration is prevention of exposure to radiation. However, prevention of radiation exposure also reduces the possibility of releases of dangerous wastes that could affect human health or the environment. This volume contains 16 appendices covering control design, chemical & particle size and radionuclide analyses, moisture and hydrology data, and maps.

25550 (DOE/RL–88-37) **2727-S nonradioactive dangerous waste storage facility closure plan.** USDOE Richland Operations Office, WA (USA). Feb 1989. 201p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90009072. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

This closure plan describes the activities for final closure of the 2727-S Nonradioactive Dangerous Waste Storage (NRDWS) facility at the Hanford site. The 2727-S NRDWS facility provided container storage for nonradioactive dangerous and extremely hazardous wastes generated in the research and development laboratories, process operations, and maintenance and transportation functions throughout the Hanford Site. For the convenience of the reviewer, a copy of the March 1987 Dangerous Waste Compliance Checklist/Questionnaire, Part 6: Closure, is included as Appendix A to this closure plan. 1 ref., 27 figs., 11 tabs.

25551 (DOE/RL–89-07-Vol.1) **Hanford Site annual dangerous waste report, Calendar year 1988: Volume 1, Generator dangerous waste report: Dangerous waste.** USDOE Richland Operations Office, WA (USA). [1989]. 211p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90009094. Available from NTIS, PC A19/MF A01 - OSTI; GPO Dep.

This volume contains data for the generator dangerous wastes at Hanford reservation for the 1988 calendar year. (KD)

25552 (DOE/RL–89-07-Vol.2) **Hanford Site annual dangerous waste report, Calendar year 1988: Volume 2, Generator dangerous waste report: Mixed waste.** USDOE Richland Operations Office, WA (USA). [1989]. 58p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90009095. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This volume contains data for the dangerous waste generated at Hanford Reservation for the 1988 calendar year. (KD)

25553 (DOE/RL–89-07-Vol.3) **Hanford Site annual dangerous waste report, Calendar year 1988: Volume 3, Treatment, storage, and disposal facility dangerous waste report: Dangerous waste.** USDOE Richland Operations Office, WA (USA). [1989]. 250p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90009096. Available from NTIS, PC A22/MF A01 - OSTI; GPO Dep.

This volume contains data for the treatment, storage and disposal facilities of dangerous wastes generated at Hanford reservation for the 1988 calendar year. (KD)

25554 (DOE/RL–89-07-Vol.4) **Hanford Site annual dangerous waste report, Calendar year 1988: Volume 4, Treatment, storage, and disposal facility dangerous waste report: Mixed waste.** USDOE Richland Operations Office, WA (USA). [1989]. 64p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90009097. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This report presents data on the Hanford Site treatment, storage, and disposal of hazardous wastes. (CBS)

25555 (DOE/RL–90-0006) **Hanford Federal Facility Agreement and Consent Order quarterly progress report for the period ending December 31, 1989.** USDOE Richland Operations Office, WA (USA). Feb 1990. 73p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90007964. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This is the third quarterly report as required by the Hanford Federal Facility Agreement and Consent Order known as the Tri-Party Agreement, established between the US Department of Energy, the US Environmental Protection Agency, and the Washington State Department of Ecology. The Tri-Party Agreement sets the plan and schedule for cleanup of nuclear weapons wastes at the Hanford Site. This report covers progress for the quarter ending December 31, 1989. 21 refs., 1 fig.

25556 (DOE/SR/18035–P-H1) **Response to Congressional Inquiry regarding seepage basins at the Savannah River Site, United States Department of Energy Savannah River Site, Aiken, South Carolina.** Westinghouse Savannah River Co., Aiken, SC (USA). Mar 1990. 159p. Sponsored by U.S. DOE Management & Administration. (WSRC-RP–89-683). Order Number DE90007956. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This report has been prepared in response to the request by the House Appropriations Committee to address the permanent isolation and containment/removal of the contaminants associated with the seepage basins at the Savannah River Site (SRS). Many of the activities regarding groundwater monitoring and status referred to in this report will be discussed in detail in a companion report on the Groundwater Monitoring Program at the SRS [WSRC-RP-89-889]. Seepage Basins are broadly defined as excavated, unlined earthen basins designed to receive and store, treat, or recharge various liquid waste streams. Not included in this report are basins containing only non-hazardous, non-radioactive constituents, such as ash basins. Fifty-four basins are discussed in this report, forty of which are inactive. Five of the remaining fourteen active basins are coal pile runoff basins, one is an ash basin that also receives coal rejects, and the remaining eight are reactor seepage basins. The Department of Energy–Savannah River (DOE-SR) has notified the South Carolina Department of Health and Environmental Control (SCDHEC) of its intent to apply for National Pollution Discharge Elimination System (NPDES) Permits for the direct discharge of disassembly basin purge water. One the permits are issued the reactor basins will be taken out of service. All of the basins discussed in this report will be remediated under Federal and/or State regulatory environmental programs. 43 figs., 6 tabs.

25557 (DP–88-125-1/2) **Waste management program: Technical progress report, January–June 1988.** . Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Plant; BE, Inc., Barnwell, SC (USA). Feb 1990. 92p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (BEI/SRL–8821-1/88). Order Number DE90007954. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report provides information on operations and development programs relating to the radioactive waste management at the Savannah River Site. Information on environmental and safety assessments, waste form development, and process and equipment development is reported for long-term waste management. 9 refs., 43 figs., 38 tabs.

25558 (DP-MS–87-95-Rev.2) **Slag-based materials for toxic metal and radioactive waste stabilization: Revision 2.** Langton, C.A. Savannah River Lab., Aiken, SC (USA). [1989]. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-890607–2-Rev.2: 3. international conference on fly ash, silica fume, slag, and natural pozzolans in concrete, Trondheim (Norway), 19-26 Jun 1989). Order Number DE90009251. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The salt solution produced at the Defense Waste Processing Facility (DWPF) is a low-level hazardous waste and has both corrosive and metal toxicity characteristics. A wasteform was designed to stabilize this solution. The objectives were: to eliminate the hazardous characteristics of the waste; and to minimize the release of potential contaminants, such as NO_3^-, so that drinking water standards would be maintained for groundwater at the perimeter of the disposal site. The ability to produce the wasteform in high volumes and emplace it in an engineered landfill was also necessary for treating and disposing of the large amount of waste. EP toxicity and TCLP testing was conducted to determine whether various saltstone mixes qualified as nonhazardous according to EPA guidelines. Impact of the design landfill on the groundwater was modeled by numeric methods. Data from laboratory leaching studies, large-scale saltstone lysimeter experiments, and disposal site characterization studies were used in the performance assessment. 9 refs., 3 figs., 3 tabs.

25559 (DPST–87-304) **Colorimetric determination of ferrous-ferric ratio in glass.** Baumann, E.W. Savannah River Lab., Aiken, SC (USA). 20 Feb 1987. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009301. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This memorandum describes a simple, rapid colorimetric procedure that can be used for analysis of vitrified melter feed. This method can replace the Moessbauer spectroscopy method for routine DWPF process control analysis. A colorimetric method has been developed that is recommended as a replacement for Moessbauer spectroscopy for process control measurements of the Fe(II)/Fe(III) ratio of melter feed for the DWPF analytical laboratory. The results agree satisfactorily with Moessbauer values. The method is suitable for remote operation and has several advantages. The total time involved is less than 30 minutes. Quantitative measurements of samples, reagents, and dilutions are unnecessary because only the ratio value is required and both Fe(II) and total Fe are measured on the same solution. Small samples (<3 mg total Fe) are required, minimizing radiation exposure, because of the high sensitivity of the colorimetric method. Relative precision and relative accuracy are about ±5%.

25560 (ENEA-RT-COMB–89-12) **Characterization of the Italian glasses and their interaction with clay.** Cantale, C.; Castelli, S.; Donato, A.; Traverso, D.M.; Kaijun, L. ENEA, Casaccia (Italy). Dipt. Ciclo del Combustibile. Oct 1989. 49p. (RT/COMB–89-12). Order Number DE90764323. Available from NTIS (US Sales Only), PC A03/MF A01.

ECC Annual Report January-December 1988 Research Contract n. FI1W-0181-I February 1989.

The objective of this research is to select a borosilicate glass composition suitable for the solidification of the HLM stream coming from the treatment of all the high level wastes stored in Italy

(MTR, CANDU and ELK RIVER) and to characterize it with reference to geological disposal. This research work is based on a pre-treatment of the waste, in order to concentrate the HLW fraction and to simplify the vitrification process by separating the greater part of the inert salts. After MCE waste pre-treatment, the resulting HLW streams are to be vitrified. Some glass compositions have been prepared and preliminary characterized. The glass named BAZ has been finally selected. The complete characterization of this glass is in progress. This paper presents the results of the physical-chemical and chemical characterizations with reference to the MCC-1 static leach test at 90 C and at a surface area to volume ratio of 10 m^{minus1}. Two leaching systems are being used: distilled water and synthetic interstitial claywater.

25561 (ENEA-RT-COMB–89-14) **Optimization and characterization of cement products incorporating ashes from radwaste incineration. Third report.** Donato, A.; Pace, A.; Ricci, G. ENEA, Casaccia (Italy). Dipt. Ciclo del Combustibile. Oct 1989. 27p. (RT/COMB–89-14). Order Number DE90764371. Available from NTIS (US Sales Only), PC A03/MF A01.

Work performed in the frame of the third (1985-89) EC programme on radioactive waste management. Task 3, item 1: Characterization of low and medium level waste forms.

The study of swelling phenomena occurring when the Nust1 and Nust2 ashes (coming from the incineration of low and intermediate level radwaste types produced at the Caorso Italian nuclear power plant) are mixed with cement shows that the phenomena are due to hydrogen coming from the oxidation of metals like aluminium in the alkaline media of the cement. The swelling can be avoided by pretreating the ashes with a NaOH 0.01 solution. The long-term leach test carried out on the cemented ashes indicates that the mixture, ash-cement 1/3 w/w, is to be given preference from the point of view of leaching resistance when the ashes are not pretreated, while for the pretreated ashes, the leaching resistance can be considered satisfactory also at a 1/2 w/w ash cement ratio, at least in the case of the Nust2 ash.

25562 (Juel–2315) **Studies on the separation and purification of strontium from the highly radioactive waste flow of fuel element reprocessing.** Tuerker, A. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Chemische Technologie der Nuklearen Entsorgung; Technische Hochschule Aachen (Germany, F.R.). Oct 1989. 108p. (In German). Order Number DE90767352. Available from NTIS (US Sales Only), PC A06/MF A01.

The quantity of spent fuel elements is increasing due to the extended peaceful uses of nuclear energy. Of the numerous fission products, strontium has an interesting application potential as a radiation or energy source for utilization in various industrial fields. A necessary condition for its use is its isolation in high radiochemical purity from the highly radioactive waste flow of the Purex process. In the present study, precipitation and coprecipitation reactions, and in particular ion exchange reactions, were chosen from among the various possible chemical and physical separation methods and examined with respect to their suitability for a selective separation of strontium from the other fission products. In selecting separation materials, particularly with respect to radiation resistance, thermal stability and selectivity, polyantimonic acid proved to be the best absorbent (even in a very acid medium) for strontium. Furthermore, the behaviour of the most important radionuclides was studied with respect to the denitration reaction from a 5 molar nitric acid solution. On the basis of the high demands made on the purity of the product, a method was developed by combining lead sulphate carrier precipitation with an ion exchange reaction on polyantimonic acid and is shown in a flow chart. (orig.).

25563 (KAERI/RR–713/88) **Radionuclide release scenario from radioactive waste repository in coastal geologic formation.** Suh, In Suk (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Kim, Jhin Wung; Kim, Chang Lak; Choi, Kwang Sub; Cho, Chan Hee. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Sep 1988. 43p. (In Korean). Order Number DE90623316. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this report, the potential pathways are described not only by spacial aspect but also by chronological order. In the spacial aspect, the potential pathways are divided by on-site pathways and off-site pathways. In chronological viewpoint, the potential pathways are categorized according to time after disposal:the operational period, the institutional control period, and the closure. The principal direction of groundwater flow can be either toward the inland fresh water sources or toward the sea. Assuming that a geologic nuclear waste repository is located in coastal area, we analyze various groundwater flow scenarios to include the hydrological characteristics in coastal area and to consider the fractured rock mass near the waste disposal facility. We adapted 'Compartmental Model' in which the seas around Korea are presented as three compartments and the world oceans are divided accordingly. Using this compartmental model, we can simulate what can be presumed to happen in the coastal area of Korea. Equations for estimation of the peak annual dose and the cumulative population dose as a result of sea food consumption are provided using the data available on the sea food catches of Korea, the ingestion rates of major sea food, the volume exchange rates among sea compartments, etc. (Author).

25564 (KAERI/RR–719/88/HY) **A study on the groundwater flow in rock masses(I).** Ahn, Jong Sung (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Kim, Chun Soo; Kim, Jong Hun; Yun, Si Tae; Kim, Kae Nam; Jeong, Chan Ho. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 178p. (In Korean). Order Number DE90622936. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The groundwater flow and hydrogeochemical evolution in the rock masses should be evaluated to assess the hydrogeological conditions in a potential area for radioactive waste disposal. The concept of groundwater flow and the relevant hydrogeological problems in rock masses are described in this report. The hydraulic parameters and field test techniques of groundwater flow in rock masses are reviewed and hydrogeochemical process and hydrodynamic dispersion are also discussed. The safety of a radioactive waste disposal system can be only assessed on the basis of mathematical models, field tests, and laboratory experiments. (Author).

25565 (KAERI/RR–722/88) **The development of safety assessment technology for the radwaste disposal.** Han, Kyong Won (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Cho, Won Jin; Lee, Han Soo; Lee, Jai Wan; Park, Chung Kyun; Lee, Myun Joo; Cho, Young Hwan; Choi, Heui Joo; Lee, Youn Myoung; Park, Hee Sung. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Feb 1989. 344p. (In Korean). Order Number DE90623317. Available from NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

This report is composed of three parts. In part I, an improved radwaste disposal safety assessment code named SADROCM, was developed by upgrading the existing SADROC. A numerical approach was adopted for the simulation of diffusion into rock pore and advection in the fracture. Also quantification of resaturation time in repository was obtained by introducing theoretical resaturation model and groundwater flow model. In radiation dose model the calculated dose by existing model was compared with that by LIMCAL code. Part II resulted in several findings. Regarding the leaching of radionuclide, two steps were observed. It was identified that in the initial step, radionuclide leaching occurred at the surface of solidified waste, and then leaching proceeded by dissolution and diffusion of radionuclide from inside of the solidified waste.The results of the sorption experiments on Cs, Co, Sr for the rock samples from four regions, showed that Kd value of F-site quartz-porphery was the lowest, and that of B-site Rhyolitic tuff the highest. E-site granite, M-site granite gneiss showed medium sorption capacities. The Kd values of each radionuclide were in the following order: Cs > Co > Sr . For the radionuclide migration through fractured rock, examination of hydraulic dispersion model and channeling model was carried out to simulate the dispersion phenomena through the fractured rock. In part III, optimum model was established which allows mathematical prediction of the container corrosion rate and leach rate.Based on this model, the equations were obtained to predict corrosion rate and radionuclide leach rate. A good agreement of these equations and existing experimental data was considered to be an indication that it can be used effectively for the estimation of long-term leaching. (Author).

25566 (KAERI/RR–741/88) **Study on the optimum evaporation conditions for forced draft evaporation system.** Jung, Ki

Jung (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Lee, Keun Woo; Yoo, Jeong Woo; Kim, Joon Hyung; Park, Hun Hwee. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 93p. (In Korean). Order Number DE90623311. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Radioactive wastes generated from the Post-Irradiation Examination Facility (PIEF) and research laboratories in KAERI are to be treated at the Radioactive Waste Treatment Facility(RWTF). Low and intermediate liquid wastes are transformed into a solidified from after volume reduction by evaporation. The condensate obtained from the evaporator is generally very low level liquid radioactive waste(VLAW), and was planned to be discharged to the environment after dilution. Later this original plan was modified by introducing Zero Release concept, further treatment of the VLAW with non-boiling forced draft evaporator system (NBFE). The existing theoretical approach was made use of to determine the facility size for the evaporation capacity and batch type experiments were performed to verify the evaporation rate. Radioisotope used for the simulated liquid waste was Cs-137 with the concentration range of 1xE-3 - 1xE-4μCi/cc. Analysis of the samples obtained during the operation was done by the Multi-Channel Analyzer. Performance test results showed that the evaporation atmospheric conditions varied 0.05 - 0.5 1/h.m^2 and the DF was over 1xE4. Environmental assessment using QAD-CG program showed that exposure dose rate for an operator would be reached about 0.035 mrem/hr which was nearly negligible and no or extremely low radioactivity in the air stream discharged(1xE-15 μCi/cc air discharged). (Author).

25567 (KAERI/RR–780/88) **Construction of solid waste form test facility.** Park, Hyun Whee (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Lee, Kang Moo; Koo, Jun Mo; Jung, In Ha; Lee, Jong Ryeul; Kim, Sung Whan; Bae, Sang Min; Cho, Kang Whon; Sung, Suk Jong. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Feb 1989. 133p. (In Korean). Order Number DE90623219. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The Solid Waste Form Test Facility (SWFTF) is now under construction at DAEDUCK in Korea. In SWFTF, the characteristics of solidified waste products as radiological homogeneity, mechanical and thermal property, water resistance and leachability will be tested and evaluated to meet conditions for long-term storage or final disposal of wastes. The construction of solid waste form test facility has begun with design of building and equipment completed in Sep. 1984, and building construction is now completed. Radioactive gas treatment system, extinguishers, cooling and heating system for the facility, electrical equipments, Master/Slave manipulator, power manipulator, lead glass and C.C.T.V. have also been installed. SWFTF will be established in the beginning of 1990's. In this report, radiation shielding door, nondestructive test of the wall, instrumentation system for the utility supply system and cell lighting system are described. (Author).

25568 (KAERI/RR–789/88) **A safety study on the wet storage of spent fuel.** Chun, Kwan Sik (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Whang, Joo Ho; Lee, Hoo Kun; Choi, Jong Won; Lee, Jong Geun. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Feb 1989. 113p. (In Korean). Order Number DE90623318. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

This study is to provide data related with a basic design of the spent fuel storage facility in the field of radiation and to establish the safety assessment methodology of away from reactor spent fuel storage facility. This is in progress and continue upto the year of 1991. The mathematical model which predict the quantity of environmental release of fission and corrosion products from spent fuel received and stored in wet storage facility operated in normal conditions was prepared. The decay characteristic of domestic spent fuels are analysed and then the coefficients for the prediction of the decay heat by simple formular was determined. This correlations could predict decay heat of spent fuel with $\pm$10% difference from ORIGEN2 results. The release factor of cobalt out of PWR spent fuel in PIE pool is 7.97 x 10-12$\approx$8.49 x 10-11 Ci/sec-rod, which appears to be linear without being connected with the types of fuel defects, but that of cesium varies with the defect type and the exposure time in water. In water condition, release factor of uranium out of CANDU fuel pellets appears to be about 5 x 10-8/day, whose tendency is similar to that of cesium of the latter half of the exposure time of water. (Author).

25569 (LA-UR–90-871) **Spallation-based science and technology and associated nuclear data requirements.** Bowman, C.D.; Lisowski, P.W.; Arthur, E.D. Los Alamos National Lab., NM (USA). [1990]. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900156–5: 2. international symposium on advanced nuclear energy research - evolution by accelerators, Mito (Japan), 24-26 Jan 1990). Order Number DE90008937. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Rapid advances in accelerator technology in recent years promise average proton beam currents as high as 250 mA with energies greater than one GeV. Such an accelerator could produce very high intensities of neutrons and other nuclear particles thus opening up new areas of science and technology. An example is the efficient burning of transuranic and fission product waste. With such a spallation-burner it appears that high-level waste might be converted to low-level waste on a time scale comparable to the human lifespan at a reasonable additional cost for electric power generation. The emphasis of this paper is on the design of a high power proton target for neutron production, on the nuclear data needed to operate this target safely and effectively, and on data requirements for transmutation. It is suggested that a pilot facility consisting of a 1.6 GeV accelerator and target operating at 25 ma is the next major step in developing this technology. Bursts of protons near the terawatt level might also be generated using such an accelerator with a proton accumulator ring. Research prospects based on such proton bursts are briefly described. The status of established nuclear data needs and of accelerator-based sources for nuclear data measurements is reviewed. 6 refs., 8 figs., 2 tabs.

25570 (LA-UR–90-1066) **The International Stripa Project: Technology transfer from cooperation in scientific and technological research on nuclear waste disposal.** Levich, R.A. (USDOE Nevada Operations Office, Las Vegas, NV (USA). Yucca Mountain Project Office); Patera, E.S.; Ferrigan, P.M.; Wilkey, P.L. Los Alamos National Lab., NM (USA). [1990]. 8p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-36. (CONF-900406–54: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90008969. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Nuclear Energy Agency of the organization for Economic Cooperation and Development (OECD/NEA) sponsors the International Stripa Project. The objectives of the Stripa Project are to develop techniques for characterizing sites located deep in rock formations that are potentially suitable for the geologic disposal of high-level radioactive wastes and to evaluate particular engineering design considerations that could enhance the long-term safety of a high-level radioactive waste repository in a geologic medium. The purpose of this paper is to briefly summarize the research conducted at Stripa and discuss the ways in which the technology developed for the Stripa Project has been and will be transfered to the United States Civilian Radioactive Waste Management Program's Yucca Mountain Project. 3 refs., 2 figs.

25571 (LBL–28329) **Dynamic use of geoscience information to develop scientific understanding for a nuclear waste repository.** Cook, N.G.W.; Tsang, C.F. Lawrence Berkeley Lab., CA (USA). Jan 1990. 7p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900406–57: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009220. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The development and safety evaluation of a nuclear waste geologic repository require a proper scientific understanding of the site response. Such scientific understanding depends on information from a number of geoscience disciplines, including geology, geophysics, geochemistry, geomechanics and hydrogeology. The information comes in four stages: (1) general regional survey data base, (2) surface-based testing, (3) exploratory shaft testing, and

(4) repository construction and evaluation. A discussion is given on the dynamic use of the information through the different stages. We point out the need for abstracting, deriving and updating a quantitative spatial and process model (QSPM) to develop a scientific understanding of site responses as a crucial element in the dynamic procedure. 2 figs.

25572 (LBL–28330) **Hydrologic characterization of faults and other potentially conductive geologic features in the unsaturated zone.** Javandel, I.; Shan, C. Lawrence Berkeley Lab., CA (USA). Jan 1990. 7p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900406–55: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009194. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The capability of characterizing near-vertical faults and other potentially highly conductive geologic features in the vicinity of a high-level-waste repository is of great importance in site characterization of underground waste-isolation projects. The possibility of using transient air pressure data at depth for characterizing these features in the unsaturated zone are investigated. Analytical solutions for calculating the pressure response of such systems are presented. Solutions are given for two types of barometric pressure fluctuations, step function and sinusoidal. 3 refs., 9 figs.

25573 (LBL–28331) **Building of a conceptual model at UE25-c hole complex.** Karasaki, K. (Lawrence Berkeley Lab., CA (USA)); Landsfeld, M.; Grossenbacher, K. Lawrence Berkeley Lab., CA (USA). Jan 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900406–58: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009203. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

US Geological Survey and Lawrence Berkeley Laboratory are attempting to construct a conceptual model of the UE25-c hole complex. An interdisciplinary approach is discussed where all the available data are integrated. Site geology, borehole geophysics and hydraulic test results at UE25-c hole complex suggest that groundwater flow may be controlled by fractures and faults. Significant clusters of fractures in the C-holes are perpendicular to bedding and may be cooling cracks or may be tectonically induced. Unresolved evidence indicates that a fault may intersect the C-holes. For these reasons a porous medium approximation of the rock in the saturated zone at the scale of a well test may be inappropriate. Instead, an Equivalent Discontinuum Model is proposed to model the UE25-c complex hydrology. EDM does not reproduce every geometrical detail of the real system, but instead, attempts to reproduce the observed behavior of the fracture system while preserving the inherent discontinuous nature of the system. 6 refs., 7 figs.

25574 (LBL–28332) **Application of geophysical methods for fracture characterization.** Lee, K.H. (Lawrence Berkeley Lab., CA (USA)); Majer, E.L.; McEvilly, T.V.; Morrison, H.F. Lawrence Berkeley Lab., CA (USA). Jan 1990. 7p. Sponsored by U.S. DOE Energy Research; U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900406–62: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009074. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

One of the most crucial needs in the design and implementation of an underground waste isolation facility is a reliable method for the detection and characterization of fractures in zones away from boreholes or subsurface workings. Geophysical methods may represent a solution to this problem. If fractures represent anomalies in the elastic properties or conductive properties of the rocks, then the seismic and electrical techniques may be useful in detecting and characterizing fracture properties. 7 refs., 3 figs.

25575 (LBL–28334) **A stratified percolation model for saturated and unsaturated flow through natural fractures.** Pyrak-Nolte, L.J. (Purdue Univ., Lafayette, IN (USA). Dept. of Earth and Atmospheric Sciences); Cook, N.G.W.; Myer, L.R. Lawrence Berkeley Lab., CA (USA). Jan 1990. 8p. Sponsored by U.S. DOE Energy Research; U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900406–60: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009217. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The geometry of the asperities of contact between the two surfaces of a fracture and of the adjacent void spaces determines fluid flow through a fracture and the mechanical deformation across a fracture. Heuristically we have developed a stratified continuum percolation model to describe this geometry based on a fractal construction that includes scale invariance and correlation of void apertures. Deformation under stress is analyzed using conservation of rock volume to correct for asperity interpenetration. Single phase flow is analyzed using a critical path along which the principal resistance is a result of laminar flow across the critical neck in this path. Results show that flow decreases with apparent aperture raised to a variable power greater than cubic, as is observed in flow experiments on natural fractures. For two phases, flow of the non-wetting phase is likewise governed by the critical neck along the critical path of largest aperture but flow of the wetting phase is governed by tortuosity. 17 refs., 10 figs.

25576 (LBL–28335) **Permeability and dispersivity of variable-aperture fracture systems.** Tsang, Y.W.; Tsang, C.F. Lawrence Berkeley Lab., CA (USA). Jan 1990. 7p. Sponsored by U.S. DOE Energy Research; U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900406–59: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009204. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A number of recent experiments have pointed out the need of including the effects of aperture variation within each fracture in predicting flow and transport properties of fractured media. This paper introduces a new approach in which medium properties, such as the permeability to flow and dispersivity in tracer transport, are correlated to only three statistical parameters describing the fracture aperture probability distribution and the aperture spatial correlation. We demonstrate how saturated permeability and relative permeabilities for flow, as well as dispersion for solute transport in fractures may be calculated. We are in the process of examining the applicability of these concepts to field problems. Results from the evaluation and analysis of the recent Stripa-3D field data are presented. 13 refs., 10 figs.

25577 (LBL–28336) **Drill-back studies examine fractured, heated rock.** Wollenberg, H.A.; Flexser, S.; Myer, L.R. Lawrence Berkeley Lab., CA (USA). Jan 1990. 8p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900406–56: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009198. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

To investigate the effects of heating on the mineralogical, geochemical, and mechanical properties of rock by high-level radioactive waste, cores are being examined from holes penetrating locations where electric heaters simulated the presence of a waste canister, and from holes penetration natural hydrothermal systems. Results to date indicate the localized mobility and deposition of uranium in an open fracture in heated granitic rock, the mobility of U in a breccia zone in an active hydrothermal system in tuff, and the presence of U in relatively high concentration in fracture-lining material in tuff. Mechanical – property studies indicate that differences in compressional- and shear-wave parameters between heated and less heated rock can be attributed to differences in the density of microcracks. Emphasis has shifted from initial studies of granitic rock at Stripa, Sweden to current investigations of welded tuff at the Nevada Test Site. 7 refs., 8 figs.

25578 (LBL–28612) **Studies of the hydraulic behavior of hierarchically fractured rock geometries.** Polek, J.M. Lawrence Berkeley Lab., CA (USA). Feb 1990. 72p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90009068. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The studies of flow through fractured rock are usually performed in field tests, laboratory experiments or numerical simulations. The emphasis of this work is the study of the hydraulic behavior of various rock geometries which lends itself best to numerical modeling. Different fracture geometries are best studied using numerical modeling, since the geometries can be created prior to the flow simulations. Throughout this paper, the term "fracture" is used as an all encompassing term for rock discontinuities, such as joints, fissures, faults and microfractures. Fractures over a range of length scales were used in the flow simulations in order to obtain realistic flow characteristics of fractured rock. The flow simulations have been broken up into two studies. The first of these studies concerns the effects of fracture length and aperture on the permeabilities of rock systems. The second study investigates the use of fractal geometry to represent the geometry of fractures. The flow stimulations conducted in these studies were accomplished by using a number of computer codes. The function of each of these codes is described and the background of modeling fractured rock is presented. 41 refs., 26 figs., 4 tabs.

25579 (ORNL/Sub–86-SA094/6) **Acceptance of spent nuclear fuel in multiple element sealed canisters by the Federal Waste Management System.** Oak Ridge National Lab., TN (USA); Johnson (E.R.) Associates, Inc., Oakton, VA (USA). Mar 1990. 219p. Sponsored by U.S. DOE Nuclear Energy; U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. (JAI–314). Order Number DE90007990. Available from NTIS, PC A10/MF A01; OSTI; INIS; GPO Dep.

This report is one of a series of eight prepared by E.R. Johnson Associates, Inc. (JAI) under ORNL's contract with DOE's OCRWM Systems Integration Program and in support of the Annual Capacity Report (ACR) Issue Resolution Process. The report topics relate specifically to the list of high priority technical waste acceptance issues developed jointly by DOE and a utility-working group. JAI performed various analyses and studies on each topic to serve as starting points for further discussion and analysis leading eventually to finalizing the process by which DOE will accept spent fuel and waste into its waste management system. The eight reports are concerned with the conditions under which spent fuel and high level waste will be accepted in the following categories: (1) failed fuel; (2) consolidated fuel and associated structural parts; (3) non-fuel-assembly hardware; (4) fuel in metal storage casks; (5) fuel in multi-element sealed canisters; (6) inspection and testing requirements for wastes; (7) canister criteria; (8) spent fuel selection for delivery; and (9) defense and commercial high-level waste packages. 14 refs., 27 figs.

25580 (ORNL/Sub–89-14384/2) **Pilot-scale testing of in situ vitrification of Arnold Engineering Development Center Site 10 contaminated soils.** Timmerman, C.L. (Pacific Northwest Lab., Richland, WA (USA)); Peterson, M.E. Oak Ridge National Lab., TN (USA). Hazwrap Support Contractor Office; Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 60p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. (PNL–7211). Order Number DE90007987. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

In situ vitrification (ISV), was initially developed to demonstrate a potential technology for disposal of soil contaminated with transuranic waste at the Hanford Site in southeastern Washington. This report presents evidence that ISV also has applicability to Arnold Engineering Development Center (AEDC) contaminated soils, which are contaminated with fuel oils and heavy metals from fire training exercises. This report presents the results of a pilot-scale ISV test conducted for Martin Marietta Energy Systems and AEDC. The primary objective of this study was to verify the applicability of the ISV process to soils contaminated with fuel oils, heavy metals, and other organics. To accomplish this objective, a pilot-scale ISV test was performed on a portion of the Site 10 Fire Training Area soil. Testing results determined the destruction of organics and the retention of inorganics in the vitrified product. Fractional release of contaminants to the off-gas treatment system and leaching characteristics of the vitrified materials were also determined. 19 refs., 28 figs., 7 tabs.

25581 (PNL-SA–17315) **Nuclear waste drum assayer.** Brodzinski, R.L.; Turner, P.J. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 5p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-900210–36: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90009177. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper describes a completely transportable, one-man-operable nuclear waste drum assayer capable of determining the concentrations of all radioisotopes in the drum. The principal radiation measuring devices are a segmented gamma-ray spectrometer utilizing a collimated germanium diode detector and two banks of neutron-sensitive proportional counters nearly surrounding the rotating drum. The neutron counters provide a sensitive measure of the transuranic activities present, and the germanium spectrometer provides a quantitative determination of the gamma-ray emitting radioactivities. The bremsstrahlung radiation from ^{90}Sr is also measured by the germanium detector and is used to quantify this isotope. Software algorithms determine the concentrations of the so-called difficult-to-measure radionuclides based on the directly measured nuclides and operator input regarding the source waste stream. The system can quantitatively sort waste into transuranic, low-level, or even the proposed new category of "below regulatory concern." 4 refs.

25582 (PNL-SA–17770) **Spent fuel and high-level waste management in selected countries: Trends and issues.** Cooley, C.R. (USDOE, Washington, DC (USA)); Schneider, K.J. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 11p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. (CONF-900406–65: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009455. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper contains descriptions of the major parameters and plans for management of spent nuclear fuel and high-level radioactive wastes in Belgium, Canada, France, the Federal Republic of Germany, Japan, Sweden Switzerland, the United Kingdom, and the United States. All nine countries are planning on disposal of spent fuel and/or high-level wastes in deep geologic repositories, although some have indicated an interest in alternatives such as seabed disposal and partitioning/transmutation. Most countries are planning on decades of interim waste storage, and are not planning to implement disposal until the year 2020 or later. Most countries plan to reprocess their spent fuel and vitrify the resulting high-level waste for disposal. Most disposal concepts utilize numerous engineered barriers that include overpacks and buffer materials. No country has finalized its repository site or concept, and only two have selected a candidate site for detailed evaluation. 7 tabs.

25583 (PNL-SA–17829) **An investigation of the mechanical and hydrologic behavior of tuff fractures under saturated conditions.** Voss, C.F.; Shotwell, L.R. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 11p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. (CONF-900406–64: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009454. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The mechanical and hydrologic behavior of natural fractures in a partially welded tuff rock were investigated. Tuff cores, each containing part of the same natural fracture oriented subparallel to the core axis, were subjected a range of stress and hydraulic gradients while simultaneously monitoring changes in the fracture aperture and volumetric flow rate. The fractures were tested in three configurations: intact, mated, and offset. Fracture deformation was nonlinear over the stress range tested with permanent deformation and hysteresis occurring with each loading cycle. The offset samples had larger permanent deformation and significantly reduced normal stiffness at lower stress levels. The cubic flow law appears to be valid for the relatively undisturbed tuff fractures at the scale tested. The cubic law did not explain the observed hydraulic behavior of the offset fractures. 6 refs., 10 figs., 2 tabs.

25584 (SAND–88-0811) **SNL Yucca Mountain Project data report: Density and porosity data for tuffs from the unsaturated zone at Yucca Mountain, Nevada.** Schwartz, B.M. Sandia

National Labs., Albuquerque, NM (USA). Feb 1990. 272p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. Order Number DE90007951. Available from NTIS, PC A12/MF A01; OSTI; INIS; GPO Dep.

Yucca Mountain, located on and adjacent to the Nevada Test Site in southern Nevada, is being evaluated as a potential site for underground disposal of nuclear wastes. At present, the physical, thermal, and mechanical properties of tuffaceous rocks from Yucca Mountain are being determined as part of the Yucca Mountain Project. This report documents experiment data, which have been obtained by Sandia National Laboratories or its contractors, for the density and porosity of tuffaceous rocks that lie above the water table at Yucca Mountain. 7 refs., 2 figs., 3 tabs.

25585 (SAND–88-2997) **A VAX/VMS mapped section/virtual memory utility package: Yucca Mountain Project.** Yarrington, L. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 37p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. Order Number DE90007950. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A VAX/VMS Mapped Section/Virtual Memory Utility Package is a collection of FORTRAN subprograms that allocate virtual memory and, optionally, map that memory to a file. The subprograms use VMS system services and run-time libraries for allocating and mapping memory; therefore, the utility package is system dependent and functional on that platform only. FORTRAN-77 is one of the most widely used languages for computer programming. Languages have been developed in the past few decades that provide more powerful tools than FORTRAN and overcome some of its limitations. Two limitations addressed by this paper which have been a source of frustration to many programmers are that (1) FORTRAN does not provide dynamic array allocation and (2) FORTRAN file input-output is very slow. The solutions presented here are for the VAX/VMS operating system and use system services that are not part of the standard FORTRAN language description. Also discussed in this paper are dynamic array allocation, mapped sections of the program memory, and support modules. 3 refs.

25586 (SAND–89-2379C) **Complexity in the validation of ground-water travel time in fractured flow and transport systems.** Davies, P.B. (Sandia National Labs., Albuquerque, NM (USA)); Hunter, R.L.; Pickens, J.F. Sandia National Labs., Albuquerque, NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005117–3: GEOVAL '90, Stockholm (Sweden), 14-17 May 1990). Order Number DE90009286. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Ground-water travel time is a widely used concept in site assessment for radioactive waste disposal. The US Department of Energy siting guidelines define ground-water travel time as the time required for a unit volume of water to travel between two locations, calculated by dividing travel-path length by the quotient of average ground-water flux and effective porosity. Defining a meaningful effective porosity in a fractured porous material is a significant problem. Although the Waste Isolation Pilot Plant (WIPP) is not subject to specific requirements for ground-water travel time, travel times have been computed under a variety of model assumptions. Recently completed model analyses for WIPP illustrate the difficulties in applying a ground-water travel-time performance measure to flow and transport in fractured, fully saturated flow systems. 12 refs., 4 figs.

25587 (UCID–21832) **Thermal and stress analysis of hot isostatically pressed, alumina ceramic, nuclear waste containers.** Chang, Yun; Hoenig, C.L. Lawrence Livermore National Lab., CA (USA). 1 Mar 1990. 16p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-7405-ENG-48. Order Number DE90010204. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Yucca Mountain Project is studying design and fabrication options for a safe durable container in which to store nuclear waste underground at Yucca Mountain, Nevada. The ceramic container discussed here is an alternative to using a metal container. This ceramic alternative would be selected if site conditions prove too corrosive to use metals for nuclear waste storage. Some of the engineering problems addressed in this study were: the stress generated in the alumina container by compressive loads when 4000 to 40,000 psi of external pressure is applied; the thermal stress in the container during the heating and cooling processes; the temperature histories of the container in various production scenarios and the power required for typical heaters; the fastest possible turnaround time to heat, seal, and cool the container commensurate with preserving the structural integrity of the ceramic and the closure; the testing of some commercial heating elements to determine the maximum available heat output; and the trade-offs between the minimization in thermal stress and cycle time for closure. 2 refs., 23 figs., 2 tabs.

25588 (UCRL–100099) **The geology of the Nevada Test Site and surrounding area: A field trip for the 28th International Geological Congress.** McKague, H.L. (Lawrence Livermore National Lab., CA (USA)); Orkild, P.P.; Mattson, S.R. Lawrence Livermore National Lab., CA (USA). Jul 1989. 48p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890702–5: 28. international geological congress, Washington, DC (USA), 9-19 Jul 1989). Order Number DE90009188. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Nevada Test Site (NTS) was established to provide an area for continental testing of nuclear devices. Geologists from the US Geological Survey (USGS) mapped much of the NTS region. These maps formed the basis for subsequent studies by geologic support groups from the Los Alamos National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratories, and the USGS. A good geologic understanding of the stratigraphy, structure, geochemistry, and physical properties of the rocks is essential for adequate containment of underground nuclear tests. Many of the recent geologic studies at NTS, particularly in Yucca Flat, Pahute Mesa, and Mid Valley, are aimed at understanding subsurface geology to help ensure complete containment. Studies performed in conjunction with nuclear testing and radioactive waste isolation have addressed many aspects of the geologic history of NTS, which have in turn greatly enhanced our understanding of the geology of the southern Great Basin. 53 refs., 3 figs., 2 tabs.

25589 (WHC-EP–0042) **PORFLO-3: A mathematical model for fluid flow, heat, and mass transport in variably saturated geologic media: Theory and numerical methods, Version 1.0.** Sagar, B. (Pacific Northwest Lab., Richland, WA (USA)); Runchal, A.K. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 130p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-87RL10930. Order Number DE90007935. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

Discharging radioactive and chemical wastes to the subsurface has been a widespread and common waste disposal practice at US Department of Energy (DOE) installations. Some of the discharges of wastes have been planned; others have been accidental. Needs have been identified for future discharges. For example, future disposal of commercially derived, high-level nuclear wastes is planned at the Yucca Mountain Site in southern Nevada. Disposal of low-level radioactive and mixed (radioactive and chemical) wastes is planned at the Hanford Site in south-central Washington State and at other DOE sites. To evaluate the safety of the proposed actions and the effectiveness of methods slated for cleanup of sites contaminated by past disposal practices, predictions of the future performance of waste isolation systems must be made. Mathematical models are analytical tools used to make these predictions and evaluations. The PORFLO-3 is one such mathematical model, the theory of which is the subject of this report. Development of a saturated-flow version of PORFLO-3 was begun in 1986 by the staff of the Basalt Waste Isolation Project (BWIP), managed by Rockwell Hanford Operations (Rockwell) for the DOE. The objective of the development work was to obtain the means to assess the performance of a proposed high-level nuclear waste repository in basalt flows beneath the Hanford Site. A two-dimensional version of PORFLO-3, known simply as PORFLO (Runchal et al. 1985; Kline et al. 1983; Eyler and Budden 1984), was in use at the BWIP from 1981 until the project was canceled by Congress in December 1987. 74 refs., 59 figs., 5 tabs.

25590 (WHC-EP–0219-Rev.1) **Environmental information management plan: Revision 1.** Michael, L.E.; Main, G.C.; See, E.J. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 127p. Sponsored by U.S. DOE Management & Administration.

DOE Contract AC06-87RL10930. Order Number DE90007963. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The Environmental Information Management Plan provides an overview of the management of environmental information generation by Hanford Site programs. The long-term nature of environmental programs requires that electronic data, documents, and other materials be kept for extended periods in a secure, controlled, and retrievable manner. An important part of the program is the maintenance of administrative records under the Hanford Federal Facility Agreement and Consent Order (Ecology et al. 1989). The Environmental Information Management Plan introduces Westinghouse Hanford records management and engineering document control systems and their relationship to environmental programs. Specific information is provided about the operation of the Environmental Data Management Center, a central facility that receives, processes, and maintains information related to environmental program activities. The Environmental Data Management Center maintains a reference file, coordinates administrative record activities, and distributes administrative record indexes and administrative record documents to the US Environmental Protection Agency, the US Department of Energy, the Washington State Department of Ecology, and four information repositories. 43 refs., 16 figs., 5 tabs.

25591 (WSRC-RP–89-321) **Checkout and start-up of the integrated DWPF [Defense Waste Processing Facility] melter system.** Smith, M.E.; Hutson, N.D.; Miller, D.H.; Morrison, J.; Shah, H.; Shuford, J.A.; Glascock, J.; Wurzinger, F.H.; Zamecnik, J.R. Westinghouse Savannah River Co., Aiken, SC (USA). 11 Nov 1989. 117p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009122. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The Integrated DWPF Melter System (IDMS) is a one-ninth-scale demonstration of the Defense Waste Processing Facility (DWPF) feed preparation, melter, and off-gas systems. The IDMS will be the first engineering-scale melter system at SRL to process mercury and flowsheet levels of halides and sulfates. This report includes a summary of the IDMS program objectives, system and equipment descriptions, and detailed discussions of the system checkout and start-up. 10 refs., 44 figs., 20 tabs.

25592 (WSRC-RP–89-485) **Remote video technology status, Defense Waste Processing Facility.** Heckendorn, F.M. II. Westinghouse Savannah River Co., Aiken, SC (USA). [1989]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-891103–68: Winter meeting of the American Nuclear Society, San Francisco, CA (USA), 26-30 Nov 1989). Order Number DE90009254. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Defense Waste Processing Facility (DWPF) is under construction at the Savannah River Site (SRS). In the DWPF an immobilization process solidifies high-level waste material into a leach-resistant borosilicate glass. The molten mixture of waste and glass is produced in an electrically heated melter. The mixture is subsequently allowed to solidify in stainless steel canisters for eventual transportation to an offsite federal repository. SRS is currently completing construction and checkout of DWPF prior to a scheduled startup in late calendar 1989. The facility relies extensively on video systems in the radioactive portions for control and information purposes. The final configuration and installation status of all of the remote video and related equipment will be reviewed in this report. 3 refs., 5 figs.

25593 (WSRC-RP–89-731) **Treatment of radioactive laboratory waste for mercury removal.** Osteen, A.B.; Bibler, J.P. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 26p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-900210–39: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90008898. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Routine analyses of Savannah River Laboratory wastes at the Savannah River Site (SRS) occasionally reveal mercury concentrations in the waste in excess of the 0.200 μg/L RCRA limit. A polystyrene/divinylbenzene ion exchange resin with thiol functional groups, Duolite GT-73, has been demonstrated effective, through a special, permitted decontamination project, for the removal of dissolved mercury from this laboratory waste. As a result of this demonstration, the resin is in use or under consideration for use with several other SRS radwaste streams as a reliable medium for mercury removal. 3 refs., 4 figs., 4 tabs.

25594 (WSRC-RP–89-961) **Technical and project highlights of the Defense Waste Processing Facility.** Dillman, E.C.; Elder, H.H.; Nichols, D.C. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 29p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-900210–40: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90009143. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Savannah River Site has been operating a nuclear fuel cycle since the early 1950s. Fuel and target elements are fabricated and irradiated to produce nuclear materials. After removal from the reactors, the fuel elements are processed to extract the products, and the waste is stored in underground tanks. During over thirty-five years of operation, approximately 83 million gallons of high level radioactive waste have been generated. This waste has been reduced to approximately 34 million gallons by evaporation in the waste tank farms. The Defense Waste Processing Facility (DWPF) will process this waste into a borosilicate glass for long-term geologic disposal. The last major construction milestone for the DWPF was reached November 30, 1989. This paper will describe the operation of the Defense Waste Processing Facility and the status of the project including the checkout and run-in of equipment and the implementation of the Startup Test Program for nonradioactive operation. 15 refs., 10 figs.

25595 (WSRC-RP–89-1026) **Simulation of benzene removal from salt solutions in stripping columns.** Georgeton, G.K.; Wood, J.P.; Wilson, B.M. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-900494–3: 1990 SCS Eastern multiconference, Nashville, TN (USA), 23-29 Apr 1990). Order Number DE90009116. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A mathematical model was used to simulate the operation of stripping columns to be used in radioactive waste processing at the Savannah River Site. The packed columns will remove trace quantities of benzene from salt solutions by contact with nitrogen. Experimental data from a pilot scale test were evaluated using the model, and the problem of stream channeling was verified with the column simulation. The benzene removal efficiency of the actual columns as a function of varying operating conditions was also simulated. 2 refs., 6 figs., 1 tab.

25596 (WSRC-RP–89-1038) **High level radioactive waste management at the Savannah River Site.** McIntosh, D.L.; Papouchado, L.M. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-900406–61: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009249. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes the High Level Radioactive Waste (HLW) generated at the Savannah River Site (SRS), outlines how it has been managed over the 35 years since site operations began, and discusses plans for future operations, with emphasis on the Defense Waste Processing Facility (DWPF) scheduled to commence operations in 1992. 45 refs., 1 fig.

25597 (WSRC-RP–89-1379) **Claymax landfill cap.** Selby, C.L. Westinghouse Savannah River Co., Aiken, SC (USA). 15 Dec 1989. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009066. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A commercial product called "Claymax" consisting of one-quarter inch of bentonite clay between two geotextile sheets is a candidate landfill cap to replace kaolin caps. A permeability apparatus incorporating a 20 foot water head was operated for 56 days to estimate a Claymax permeability of 2×10^{-9} cm/sec compared with 10^{-8}, the EPA max for a burial site cap. 1 fig.

25598 (WSRC-TR–90-18) **Development of a nuclear waste glass product consistency test.** Bibler, N.E.; Jantzen, C.M.; Plodinec, M.J. Westinghouse Savannah River Co., Aiken, SC (USA). 5 Jan 1990. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009248. Available from NTIS, PC A03/MF A01 - OSTI.

Construction of the nation's first facility to immobilize high-level nuclear waste is nearing completion at the Savannah River Site (SRS) at Aiken, SC. In the Defense Waste Processing Facility (DWPF), the waste resulting from over thirty years of reprocessing of nuclear fuels for national defense purposes will be immobilized in durable borosilicate glass. A leach test was needed which was easily reproducible and could be performed remotely on highly radioactive samples, and could yield reliable results rapidly. Several standard leach tests were examined, with a wide variety of test configurations. The DWPF Product Consistency Test (PCT) has been developed in which crushed glass samples are exposed to 90°C deionized water for seven days. In this paper, the vitrification process and product are described, as well as the product specifications, to provide a background for the use of the test. Test development, and the results of confirmatory testing are then presented. 18 refs., 3 figs., 4 tabs.

25599 **Characterization and treatment of wastes comprised of hazardous, radioactive mixed, and transuranic fractions.** Nelson, J.T. (NUS Corp., Oak Ridge, TN (USA)); Martineit, R.A.; Helms, R.E. pp. 591 of Proceedings of the second international conference on new frontiers for hazardous waste management. . Environmental Protection Agency (US), Cincinnati, OH (USA) (1987). (CONF-870941–: 2. international conference on new frontiers for hazardous waste management, Pittsburgh, PA (USA), 27-30 Sep 1987).

EPA/600/9-87/018F.

This study addresses the characterization and treatment of a stratified radioactive wastewater stored in large underground tanks. The waste was tested in light of: USEPA's RCRA guidelines for hazardous wastes; and the Department of Energy's (DOE's) guidelines for radioactive mixed waste (RMW), low-level waste (LLW), and transuranic (TRU) waste. Following these determinations, a regulatory analysis was performed to define the management guidelines for the various waste types. This analysis involved: USEPA/state hazardous-waste and wastewater regulations; applicable DOE Orders;; and various guidelines promulgated by both DOE and the Nuclear Regulatory Commission (NRC). The study addresses the treatment, storage, and disposal of the various waste types.

25600 **Structure of Na in aluminosilicate glasses: A far-infrared reflectance spectroscopic study.** Merzbacher, C.I. (Pennsylvania State Univ., University Park (USA)); White, W.B. *American Mineralogist (USA),* 73(9-10): 1089-1094 (Sep-Oct 1988). DOE Contract FG02-84ER45077.

Infrared reflectance spectra of two strategically selected series of glasses in the Na_2O-Al_2O_3-SiO_2 system have been measured. One series is along the SiO_2-$NaAlO_2$ join with NBOT/T = 0. The other series is on the Na_2O-SiO_2 binary with NBO/T from 0.67 to 1.33. Kramers-Kronig analysis was performed, and the far-infrared region of the computed dielectric loss function is interpreted in terms of changes in the Na structural environment. On the basis of the strong, positive, linear correlation between peak height and Na content, the observed far-infrared peak is assigned to vibration of the Na ions. The Na mode occurs at 85 cm^{-1} in the spectra of all the fully polymerized glasses. The vibrational energy increases with depolymerization, to 150 cm^{-1} for the most depolymerized glass, owing to the gradual collapse of the tetrahedral framework structure. Calculated Na-O force constants range from 10 N/m for the fully polymerized glasses to 30 N/m for the most depolymerized composition. The results of this study agree with a structural model, for glasses with Na/Al $\geq$ 1.0, in which Na charge-balances tetrahedral Al, with excess Na acting as network modifiers and depolymerizing the structure.

0530 Environmental Aspects

Refer also to citation(s) 25543, 25544, 25545, 25546, 25547, 25548, 25549, 25550, 25557, 25563, 25565, 25570, 25571, 25572, 25573, 25575, 25576, 25577, 25578, 25584, 25609, 25909, 26558

25601 (NUREG/CR–5381) **Economic risk of contamination cleanup costs resulting from large nonreactor nuclear material licensee operations.** Philbin, J.S. (Sandia National Labs., Albuquerque, NM (USA)); Saloio, J.H.; Rollstin, J. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Low-Level Waste Management and Decommissioning; Sandia National Labs., Albuquerque, NM (USA); ERC Environmental and Energy Services Co., Albuquerque, NM (USA); GRAM, Inc., Albuquerque, NM (USA). Mar 1990. 176p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–89-1302). Available from NTIS, PC A09/MF A01 - GPO; OSTI; INIS.

Several potential incident scenarios involving the accidental release of radioactive material at five reference, nonreactor nuclear material licensees are analyzed in this report. The economic risk ($/licensee/yr) of decontamination is evaluated for each reference licensee. Although most releases and cleanup costs are minor, some less frequent incidents may result in very high cleanup costs that dominate the economic risk of decontamination of a particular licensee. The economic risk for the 5 plants ranged from a low of $14,000 per licensee per year to a high of $104,000 per licensee per year. This report is the second of two reports by Sandia National Laboratories on the economic risk of nonreactor nuclear material licensee operations. 40 refs., 21 figs., 31 tabs.

25602 (ORNL/RASA–88/32) **Results of the radiological survey at West Hunter Avenue Firehall, Maywood, New Jersey (MJ027).** Foley, R.D.; Floyd, L.M. Oak Ridge National Lab., TN (USA). Mar 1990. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90009260. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. At the request of the US Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally ^{232}Th, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, West Hunter Avenue Firehall, Maywood, New Jersey (MJ027), was conducted during 1987. 4 refs., 3 tabs.

25603 (ORNL/TM–11482) **Data package for the Atomic Vapor Laser Isotope Separation (AVLIS) plant environmental impact statement.** Saylor, R.E. (Oak Ridge National Lab., TN (USA)); Jernigan, D.G.; Lasley, B.D.; Mann, L.K.; Schweitzer, M.; Staub, W.P.; Tolbert, V.R.; Van Dyke, J.W.; Witherspoon, J.P.; Wolfe, A.K. Oak Ridge National Lab., TN (USA). Feb 1990. 694p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90009445. Available from NTIS, PC A99/MF A01 - OSTI; GPO Dep.

The US Department of Energy (DOE) is investigating the feasibility of constructing and operating the first Atomic Vapor Laser Isotope Separation (AVLIS) plant for uranium enrichment. This document provides environmental data to support the preparation of an environmental impact statement (EIS) for the AVLIS project. It contains background environmental information for the two operating DOE uranium enrichment plants and the one that has been shut down: (1) the Oak Ridge Gaseous Diffusion Plant in Oak Ridge, Tennessee (shut down); (2) the Paducah Gaseous Diffusion Plant near Paducah, Kentucky; and (3) the Portsmouth Gaseous Diffusion Plant near Portsmouth, Ohio. These three existing uranium enrichment plants are candidate sites for the AVLIS plant. Environmental information regarding other potential sites will be collected separately, if necessary, during the preparation of the AVLIS EIS. The data package is organized by environmental topic: air quality/meteorology, geology, seismicity, surface water, groundwater, radiological environment, terrestrial ecology, aquatic ecology, and socioeconomics. Site environmental information was collected from

a variety of sources, including plant site visits, annual plant site environmental reports, information generated for remedial action activities, and surveys of local communities for socioeconomic information. All information is referenced to provide the preparers of the AVLIS EIS with the source material for information given in this data package. This report also serves as a guide to other information that exists in separate environmental documentation.

0540 Health and Safety

Refer also to citation(s) 25507, 25523, 25528, 25543, 25555, 25556, 25570, 25571, 25579, 25589, 25590, 25599, 25601, 26528, 26766, 26770, 26771, 27122, 27208, 27209

25604 (CONF-880558–, pp. 125-131) **Safety evaluation of the transport container for natural uranium-hexafluoride under fire accident.** Yamakawa, Hidetsugu (Central Research Institute of Electric Power Industry, Tokyo (Japan)); Shiomi, Satoshi; Ozaki, Sachio; Abe, Hirotoshi; Kobayashi, Seiichi. Oak Ridge Gaseous Diffusion Plant, TN (USA). 1988. From Uranium hexafluoride–safe handling, processing, and transporting conference; Oak Ridge, TN (USA); 24-26 May 1988. In *Uranium hexafluoride: Safe handling, processing, and transporting: Conference proceedings.* Order Number DE88010460. Available from NTIS, PC A11/MF A01.

The land transportation of 48Y-cylinder filled with natural uranium-hexafluoride (UF6) is scheduled to start this year from Tokyo Harbor to the enrichment plant at Ningyou-pass in Okayama Prefecture. In this study, heat resistance capability analyses of 48Y-cylinder filled with 12.5-ton of natural UF6 under the condition of 800 C for the duration of 30 minutes were conducted. The authors developed a simple modeling technique for heat resistance analysis of UF6 packages which gives conservative and reasonable solutions, with two-dimensional or axi-symmetric models. Also, the effect of heat protective covers was examined analytically. The evaluated items of this 48Y-cylinder are as follows: The hydraulic breaking of cylinder by expansion of UF6 in liquid phase; The breaking of the cylinder by vapor pressure increasing of UF_6 and the effect of the strength lowering of highly heated steel; and leakage of UF_6 by melting soft solder of the valve and loss of integrity of containment. According to the results of preliminary analyses, temperature of 48Y-cylinder without heat protective instruments reached the melting point of soft solder (about 203 C) in 2 or 3 minutes after the analysis had started. From this point of view and public acceptance (PA), the authors determined to mount the heat protective covers, 14 mm thickness, in the both ends of the cylinder. Fire resistance analyses of the 48Y-cylinder filled with UF_6 were carried out. As material properties of natural UF_6, the data which were obtained through the study of PNC (Power Reactor and Nuclear Fuel Development Corporation) and the values listed in other papers were used. For numerical analysis, ABAQUS, a general purpose F.E.M. program for non-linear problems was used.

25605 (DOE/EH–90008879) **Training Accreditation Program: Training program manual: TAP 1.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (USA). 1 Mar 1989. 50p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90008879. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In recent years increased attention has been given to all aspects of the operation of Department of Energy (DOE) nuclear facilities. Contributing to this is the finding that the severity of the accident at Three Mile Island in 1979 has, in large part, been attributed to personnel training deficiencies. Initially the impact of the Three Mile Island accident and the lessons learned were directed at DOE Category A reactor facilities. This resulted in numerous initiatives to upgrade the safety of operations and to improve the training of personnel responsible for operating these facilities.

25606 (DOE/EH–90008881) **Training Accreditation Program: Training program support manual: TAP 3.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (USA). 1 Mar 1989. 185p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90008881. Available from NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.

The Training Accreditation Program establishes the objectives and criteria against which DOE nuclear facility training is evaluated to determine its readiness for accreditation. Training programs are evaluated against the accreditation objectives and criteria by facility personnel during the initial self-evaluation process. From this self-evaluation, action plans are made by the contractor to address the scope of work necessary in order to upgrade any deficiencies noted. This scope of work must be formally documented in the Training Program Accreditation Plan. When reviewed and approved by the responsible Head of the Field Organization and cognizant Program Secretarial Office, EH-1 concurrence is obtained. This plan then becomes the document which guides accreditation efforts for the contractor.

25607 (DOE/ID–10276) **TMI-2: Lessons learned by the US Department of Energy: A programmatic perspective.** Schmitt, R.C. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Reno, H.W.; Bentley, K.J.; Owens, D.E. EG and G Idaho, Inc., Idaho Falls, ID (USA). Mar 1990. 108p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90007981. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

This report is a summary of the lessons learned by the US Department of Energy during its decade-long participation in the research and accident cleanup project at Three Mile Island Nuclear Power Station Unit 2 near Harrisburg, Pennsylvania. It is based on a review of a wide range of project documents and interviews with personnel from the many organizations involved. The lessons are organized into major subjects with a brief background section to orient the reader to that subject. The subjects are divided into subtopics, each with a brief discussion and a series of lessons learned. The lessons are very brief and each is preceded with a keyword phrase to highlight its specific topic. References are given so that the details of the subject and the lesson can be further investigated. 99 refs., 24 figs.

25608 (ORNL/M–1082) **The spill prevention, control, countermeasures, and contingency plans for Oak Ridge National Laboratory.** Oak Ridge National Lab., TN (USA). Jan 1990. 518p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009433. Available from NTIS, PC A22/MF A01 - OSTI.

The Spill Prevention, Control, Countermeasures, and Contingency (SPCCC) Plans for Oak Ridge National Laboratory (ORNL) are written to comply with federal/state regulations requiring a written plan. The SPCCC Plans are formulated to serve as a guide for Laboratory personnel when responding to releases of oils or hazardous substances. The purpose of these plans is to ensure that spills or releases are safely contained and recovered in a manner that best ensures personnel safety and protection of the environment.

25609 (WHC-SA–0708) **The Hanford Site: Then, now, and tomorrow.** Izatt, R.D. (USDOE Richland Operations Office, WA (USA)); Babad, H.; Dixon, W.T.; Lerch, R.L. Westinghouse Hanford Co., Richland, WA (USA). Feb 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900210–38: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90009334. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Environmental restoration and waste management have become a primary focus at Hanford Site. A schedule has been prepared for cleaning up the approximately 1,100 waste management units and for decontaminating and decommissioning over 100 facilities. The cleanup effort includes the implementation of the Resource Conservation and Recovery Act of 1976 and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as well as technology development and the construction and operation of new facilities. 5 refs.

25610 (WHC-SA–0877) **Sampling plan for the unconditional release of building materials and similar large components encountered in decommissioning.** Gardner, D.L. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 6p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-87RL10930. (CONF-9003134–1: 1990 Health Physics

Society meeting, Richland, WA (USA), 22 Mar 1990). Order Number DE90009134. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The most efficient sampling plan for the unconditional release of building materials and similar large components encountered in decommissioning can be developed without requiring 100% coverage by measurements on all surfaces. This plan was implemented in the decommissioning of the Shippingport Atomic Power Station. The backbone of the plan was the checking and rechecking of the candidate material so that there was a high degree of assurance that it was releasable before the final survey was performed. This is illustrated diagrammatically in Figure 1. 1 fig., 1 tab.

25611 (WSRC-RP–89-830) **Evaluation of cloths for decontamination by wiping.** Rankin, W.N. (Westinghouse Savannah River Co., Aiken, SC (USA)); Reiff, D.J.; Fink, S.D.; Luckenbach, R.L. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-900210–37: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90009131. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Treated polyester cloth was evaluated in laboratory-scale and larger-scale tests as an alternative to atomic wipes and cotton cloth for use in decontamination by wiping. The advantages of the treated polyester are as follows: does not react with nitric acid to form unstable product, more fire resistant, less volume of radioactive waste generated (versus atomic wipes), and product can be recovered by soaking the polyester cloths in nitric acid. Results are that even though treated polyester wiping cloths are slightly less effective than atomic wipes and cotton cloth, its many other benefits greatly outweigh this slight disadvantage. 5 figs.

25612 (WSRC-RP–89-1445) **Risks of nuclear fuel reprocessing.** Durant, W.S. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 29p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009255. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Savannah River Site's primary function is the production of weapons materials. It consists of four reactors, two fuel reprocessing facilities, a fuel fabrication facility, a nuclear fuel facility for the Navy and a heavy water recycle facility. Under construction is a facility to convert the site's liquid wastes into borosilicate glass. The topic of this paper is risks of nuclear fuel reprocessing. Also discussed are facility operations. 18 figs.

25613 (WSRC-RP–90-143) **Analysis of SRS [Savannah River Site] industrial fire records.** Brandyberry, M.D. Westinghouse Savannah River Co., Aiken, SC (USA). Jan 1990. 36p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009276. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Savannah River Site has many operating years of experience with various facilities. Fires have occurred throughout the years at many of these facilities, but in general with only minor consequences. There has never been a fire related loss of life or serious injury on site. The maximum dollar loss of a single fire was approximately $400,000 involving a coal and oil fire in D area. the following is a synopsis of data included in the fire division Industrial Fire records from January of 1958 until November of 1989. It includes fires from all areas on site which were attended by or reported to the fire division. The fires are characterized by number of occurrences, site areas and buildings in which they occurred, dollar losses sustained, the cause of the fire, and what type of suppression method was used to extinguish the fire. The reactor areas are included in all discussions of site wide fires, but are also singled out and analyzed separately due to perceived significance of fires there. Discussion of the completeness of the Industrial Fire data base is also included. 29 figs., 3 tabs.

0550 Safeguards, Inspection, and Accountability

Refer also to citation(s) 25533, 25619, 26515, 27357

25614 (ENEA-RT-COMB–88-09) **SARA: A simulation computer code for NRTMA performances study at EUREX pilot reprocessing plant.** Aparo, M.; Dionisi, M.; Vicini, C.; Zeppa, P.; Frazzoli, F.V.; Remetti, R.; Portale, C. ENEA, Casaccia (Italy). Dipt. Ciclo del Combustibile; Rome Univ. (Italy). Dec 1988. 35p. (RT/COMB–88-9). Order Number DE90764346. Available from NTIS (US Sales Only), PC A03/MF A01.

Nuclear Material Accountability, supported by Containment and Surveillance measures, is a fundamental means for an effective International Safeguard implementation in nuclear plants. Accountability is based on the verification that the difference between a material quantity entering a given material balance and the quantity leaving that area in a given period of time, corresponds to the amount of material actually present at the moment of the inspection. In the recent years International Safeguards appealing to the needs of timeliness in detecting diversion and concealing activities, devoted R&D efforts on a new Dynamic Accountability procedures (NRTMA) with particular concern in reprocessing plants. The present paper, which is the result of a research activity carried out in the frame of the Italian support programme to IAEA for Safeguards implementation, deals with a feasibility study of a NRTMA system to be applied to the EUREX pilot reprocessing plant. Such a feasibility study was performed by developing a computer program based on simulated plant generated data.

25615 (KAERI/RR–735/88) **Technology development on nuclear material accountability.** Hong, Jong Sook (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Lee, Byung Doo; Cha, Hong Ryul; Choi, Hyoung Nae; Park, Ho Joon; Song, Hyun Suk. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Jan 1989. 89p. (In Korean). Order Number DE90623193. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

A portable HPGe, MCA and gamma-ray spectrometer has been used passive non-destructively for the rafid field measured of U-235 enrichment. Measurement of the 185.7 keV gamma-ray emitted by U-235 appeared most promising for this application. The factors influencing this measurement were identified as the effect of source to detector distance, self-absorption effect by various sample composition, attenuation effect by the wall thickness of sample container, collimation effect and counting efficiency. These factors were separately evaluated, and adjusted to obtain the optimized total counting system. The selected samples which of 55 gal. natural and depleted UO_2 powder, and type 48Y depleted UF_6 cylinder were measured and resulted in relative errors of 2.67%, 4.93% and 5.52% at 95% confidence level respectively from Tag values. As a result of this study the quantitative non-destructive assay method could be applied not only to uranium sample but to any radio-isotope sample which emits signature gammas provided inherent instrumental error ranges are acceptable. In addition, the computer program developed in 1987 for nuclear material accountings at both facility and state levels, was updated and reinforced particularly in the error checking function to minimize the errors caused by computer key-board operations. (Author).

25616 (SAND–90-0863C) **Performance testing biometric verifiers.** Maxwell, R. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005153–1: Advanced security and identification technologies conference, Washington, DC (USA), 29 May - 1 jun 1990). Order Number DE90008679. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The performance and availability of the five basic identity verifiers can now meet the requirements of most physical and information security needs. However, with the lack of any evaluation standards, the independent testing of verifiers requires care with due consideration for both parts of the verifier systems; the verifier hardware and software and the user with his biometric features which is the least consistent part of the system. The method of testing and data processing must be done with care and should be reported along with reduced results.

0560 Legislation and Regulations

Refer also to citation(s) 25517, 25526, 25599, 25784, 27146, 27147, 27148, 27208

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0701 Physical Isotope Separation

Refer also to citation(s) 25510

25617 (AD-A-216382/2/XAB) **Computer simulation of electromigration in thin films. Final report, November 1987-October 1988.** Huntington, H.B.; Meng, P.P.; Shy, Y. Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Physics. Oct 1989. 21p. Available from NTIS, PC A03/MF A01.

Computational results of modelling electromigration in metal stripes without passivation but with reasonably realistic grain and grain-boundary configurations representing both unannealed and annealed strips have shown moderate reductions in a measure of damage by electromigration in the annealed case.

25618 (PB-90-858929/XAB) **Laser isotope separation: Non-uranium applications. January 1976-November 1989 (A Bibliography from the Searchable Physics Information Notices data base). Report for January 1976-November 1989.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 78p. Available from NTISPC N01/MF N01.

Supersedes PB-82-870775.

This bibliography contains citations concerning research and development of laser isotope separation technology for other than uranium applications. Applications for boron, hydrogen, nitrogen, potassium, and sulfur are among the elements included. Thermal effects generated by the laser on the separation process, selectivity of dissociation, efficiency evaluations of the separation process, and theoretical investigations into the process are also included. (This updated bibliography contains 165 citations, 65 of which are new entries to the previous edition.)

0702 Radiation Sources

Refer also to citation(s) 25795, 26228, 26229, 26276, 26282, 26289, 26292, 26293, 26296, 26497

25619 (ENEA-RT-DISP-88-05) **ENEA monitoring of ionizing radiation activity levels from radioactive sources (sealed and unsealed) used in Italy during 1979-1984.** Lavorante, F.; Vuoio, M. ENEA, Rome (Italy). Direzione Sicurezza Nucleare e Protezione Sanitaria. Dec 1988. 62p. (In Italian). (RT/DISP-88-5). Order Number DE90764342. Available from NTIS (US Sales Only), PC A04/MF A01.

Notifications concerning the radioisotopes and their activities used in Italy sent to ENEA (Italian Commission for Alternative Energy Sources) are reported. The trend of the total activities notified in the period 1979-1984 is presented in this report, together with distributions versus type of use, type of source, physical status and geographical distribution.

25620 (KAERI/RR-797/88) **The development of silicon doping technique by neutron transmutation.** Kim, Huhn Jun (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Kim, Yong Che; Kim, Jeong Do; Jun, Byung Chil; Lee, Chang Hee; Lee, Jeong Soo; Seong, Baek Seok; Shim, Hae Seop; Choi, Byung Hoon; Ho, Jong Wha. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). May 1989. 144p. (In Korean). Order Number DE90623202. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

This is the interim report for the technique/facility development of neutron transmutation doping (NTD) to be performed at new research reactor, KMRR(30MW) which is under construction at KAERI. The first year's scope and contents of this project include evaluation and plan of fundamentals such as evaluation of neutron field, irradiation technique, design of mechanical driving and electronic control units, etc.. 1.The thermal neutron flux and quality are estimated for the irradiation holes, NTD-1 and NTD-2 in KMRR respectively and results turned out to be appropriate for the NTD. 2.As for the uniform irradiation method, both 'fixed position method' and 'constant velocity method' are chosen as optimal ones. Real-time monitoring for the neutron irradiation is to be executed by means of 4 SPND units/hole. 3.The NTD irradiation system is preferably to be a semi-automation at the initial stage. After acquiring enough experience with NTD operation and being assured of compatibility with other experimental facilities, a full-scale automatic system is to be developed. Mechanical driving unit is to be operated with independent up-down and rotation of Si ingot motion by using servo motor and IBM /AT so that both fixed position and constant velocity methods can be operated. 4.Studies are in progress for the precise measurement of the absolute neutron flux distribution in irradiation holes. (Author).

25621 (PB-90-858879/XAB) **Curing of polyurethane coatings: Radiation curing. January 1980-November 1989 (A Bibliography from World Surface Coatings Abstracts). Report for January 1980-November 1989.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 50p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the curing of urethane and polyurethane coatings by electromagnet radiation. This bibliography is specific to electric and/or magnetic curing as compared to photocuring or ultraviolet curing, which are treated as separate bibliographies. These coatings may be described as inks, paints, lacquers, adhesives, or specialized coatings. Special applications of this technology in the magnetic recording media industry are presented. (Contains 98 citations fully indexed and including a title list.)

0703 Isotopic Power Supplies

Refer also to citation(s) 25777, 26004, 26005, 26007, 26008, 26009

25622 (DPST-89-372) **GPHS [General Purpose Heat Source] uranium oxide encapsulations supporting satellite safety tests.** Kanne, W.R. Savannah River Lab., Aiken, SC (USA). 24 Apr 1989. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009247. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

General Purpose Heat Source (GPHS) simulant-fueled capsules were assembled, welded, nondestructively examined, and shipped to Los Alamos National Laboratory (LANL) for satellite safety tests. Simulant-fueled iridium capsules contain depleted uranium oxide pellets that serve as a stand-in for plutonium-238 oxide pellets. Information on forty seven capsules prepared during 1987 and 1988 is recorded in this memorandum along with a description of the processes used for encapsulation and evaluation. LANL expects to use all capsules for destructive safety tests, which are under way. Test results so far have demonstrated excellent integrity of the Savannah River capsule welds. 10 refs., 5 figs., 3 tabs.

0705 Health and Safety

Refer also to citation(s) 26005

08 HYDROGEN

Refer also to citation(s) 26263

0801 Production

Refer also to citation(s) 25270

0802 Storage, Transport, and Handling

25623 (FRCEA-TH-247) **Study of hydrogen diffusion in amorphous and crystalline hydrides of the alloy Zr_2Ni by**

gamma-gamma perturbed angular correlations of ^{181}Ta. Chikdene, M.A. CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Recherche Fondamentale; Grenoble-1 Univ., 38 (France). 1989. 170p. (In French). Order Number DE90770327. Available from NTIS (US Sales Only), PC A08/MF A01.

The diffusion of hydrogen in crystalline hydrides Zr_2NiH_x (x = 2.1, 3 and 4.8) and amorphous hydrides of Zr_2Ni with x = 2.5 and 4.5, has been studied by Perturbed Angular Correlation spectroscopy using ^{181}Ta as a probe in substitution for zirconium. The quadrupole relaxation of the ^{181}Ta spins produced by hydrogen motions was observed between 170 K and 470 K. The activation energy and pre-exponential frequency factors were deduced from the temperature dependence of the quadrupole relaxation constant in both crystalline and amorphous hydrides. In crystalline hydrides our results are consistent with those previously reported from ^{1}H NMR experiments. Combining the PAC data with the results of neutron diffraction experiments performed on crystalline deuterides, we are able to propose a mechanism for hydrogen jumps in these hydrides using a single geometrical model. In the amorphous hydrides our PAC results are consistent with the existence of a short-range ordering or microsegregation induced by the hydrogen loading process in the amorphous lattice. However, our data do not indicate the existence of broad distributions of the activation energy for hydrogen jumps.

09 BIOMASS FUELS

0908 Production

25624 (DOE/CE/15270–T12) **Explorations of mechanismms regulating ectomycorrhizal colonization of boron-fertilized pine: Quarterly report, October 1, 1989–January 1, 1990.** Garrett, H.E.; Begonia, G.; Sword, M.A. Missouri Univ., Columbia, MO (USA). 8 Jan 1990. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-86CE15270. Order Number DE90005366. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Research continued on the effects of ectomycorrhizal on the effects of ectomycorrhizal inoculation, and fertilization with boron, on the physiology and morphology of shortleaf pine seedling root systems. Ectomycorrhizal colonization has been assessed. An initial trial for determination of root indole acetic acid content has also been performed. Also, the task on the evaluation and effectiveness of phenolase in metabolizing toxic phenolic compounds, was started. 2 tabs.

25625 (HC–CR-85-04) **Woodchip harvesting and handling, Abitibi-Price Inc. - Grand Falls.** Highlands Contracting Ltd., Gander, NF (Canada). Dec 1985. vp. (CE–02983). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report covers the trials of a variety of improvement in the technique for the production of woodchip fuel from whole trees, carried out between 1981 and 1984 by Abitibi-Price Limited for their paper mill in Grand Falls, Newfoundland. The testing of these improvements is described, as is installation of a hydraulic dumper for tractor-trailer vans and its effects on production. The chips harvested from pure hardwood stands were found to be economic, with a heat value of 1.1 barrels of fuel oil per tonne, resulting in a saving of $5.92 per tonne. Integrating pulpwood logging and chip harvesting was not economical. Changing to mechanical felling produced only small savings. The dumper reduced costs, but did not improve productivity. However, it did permit an expanded use of waste material as fuel. Experience from New Brunswick indicates that productivity could still be improved. 1 ref., 10 figs., 20 tabs.

0909 Processing

Refer also to citation(s) 26337

25626 (AFME–86-09-0036) **Energetic up-grading of agricultural wastes.** Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1986. 207p. (In French). Order Number DE90770653. Available from NTIS (US Sales Only), PC A10/MF A01.

The high pressure densification or compaction of several agricultural wastes is experimentally studied with a piston press: coffee shells, palm tree wastes, peanut shells, corn and sorghum stalks, rice, grass and cocoa wastes. The combustibility of the densified wastes is also tested. A technical and economical evaluation of the fabrication of briquets and of their industrial or domestic application, or for the production of electricity is presented. The coffee shell utilization is studied in details.

25627 (DOE/ER/13898–1) **[Cellulose fermentation by nitrogen-fixing anaerobic bacteria]: Progress report, December 1, 1988–November 30, 1989.** Massachusetts Univ., Amherst, MA (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER13898. Order Number DE90008976. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This progress report covers research performed during the last five months of year 1 and the first seven months of year 2 of the project. Our research during this period dealt with physiological interactions between cellulolytic bacteria and commensal bacteria, chemotaxis of cellulolytic bacteria and its postulated role in natural environments, characterization of the cellulase complex of N_2-fixing Clostridium strain C7, and the effects of nitrogen fixation on cellulose fermentation.

25628 (PNL–7245) **Testing of an advanced thermochemical conversion reactor system.** Pacific Northwest Lab., Richland, WA (USA); Manufacturing and Technology Conversion International, Inc., Columbia, MD (USA). Jan 1990. 177p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. Order Number DE90007989. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

This report presents the results of work conducted by MTCI to verify and confirm experimentally the ability of the MTCI gasification process to effectively generate a high-quality, medium-Btu gas from a wider variety of feedstock and waste than that attainable in air-blown, direct gasification systems. The system's overall simplicity, due to the compact nature of the pulse combustor, and the high heat transfer rates attainable within the pulsating flow resonance tubes, provide a decided and near-term potential economic advantage for the MTCI indirect gasification system. The primary objective of this project was the design, construction, and testing of a Process Design Verification System for an indirectly heated, thermochemical fluid-bed reactor and a pulse combustor an an integrated system that can process alternative renewable sources of energy such as biomass, black liquor, municipal solid waste and waste hydrocarbons, including heavy oils into a useful product gas. The test objectives for the biomass portion of this program were to establish definitive performance data on biomass feedstocks covering a wide range of feedstock qualities and characteristics. The test objectives for the black liquor portion of this program were to verify the operation of the indirect gasifier on commercial black liquor containing 65 percent solids at several temperature levels and to characterize the bed carbon content, bed solids particle size and sulfur distribution as a function of gasification conditions. 6 refs., 59 figs., 29 tabs.

0920 Combustion

Refer also to citation(s) 25626, 25635

25629 (LBH–487-067) **A catalogue of small scale combustors for biomass fuels.** Cotton, T.; Graham, R.G.; Huffman, D. Ensyn Engineering Associates, Inc., Ottawa, ON (Canada); Levelton (B.H.) and Associates Ltd., Vancouver, BC (Canada). Sep 1988. 163p. Contract EMR 51SZ 23216-6-6287. (CE–02927). Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

The equipment covered in this catalogue deals with the conversion of a wide variety of biomass-derived solid fuels to thermal energy via direct combustion in a excess of air. The catalogue is directed at small scale user applications in the range of 0.1 to 21

GJ/h energy output. It does not include systems for the thermochemical conversion of biomass to an intermediate fuel form by processes such as gasification or liquefaction. The catalogue is divided into three sections and the format has been designed to allow easy matching of user application to system design. A brief description is presented covering the types of fuels commonly included in the bioenergy sector and the generic energy system designs presently avilable. A second section gives the user the procedures for equipment selection and presents an equipment reference guide. The final section contains system descriptions and characteristics for each supplier. The systems are commercially available to potential Canadian users and the majority are industrially proven, often with a significant number of operating installations. Information is presented as supplied by the equipment distributors. No attempt has been made to screen data for authenticity, applicability or relevance. Therefore, it is possible that some systems, may not be industrially proven or even appropriately demonstrated. 8 figs., 2 tabs.

25630 (ODNRI-B–17) **Producer gas fuelling of a 20kW output engine by gasification of solid biomass.** Hollingdale, A.C.; Breag, G.R.; Pearce, D. Overseas Development Natural Resources Inst., Chatham (UK). Nov 1988. 20p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Motive power requirements in the range up to 100 kW shaft power are common in developing country processing operations. Producer gas-fuelled systems based upon a relatively cheap and simple manually operated gasifier or reactor using readily available biomass feedstock can offer in some cases an attractive alternative to fossil-fuelled power units. This bulletin outlines research and development work by the Industrial Development Department of the Overseas Development Natural Resources Institute for 20 kW shaft power output from producer gas derived from solid biomass. Biomass materials such as wood or shells can be carbonized to form charcoal or left in the natural uncarbonized state. In this work both carbonized and uncarbonized biomass fuel has been used to provide producer gas to fuel a Ford 2274E engine, an industrial version of a standard vehicle spark-ignition engine. Cross-draught and down-draught reactor designs were evaluated during trials with this engine. Also different gas cleaning and cooling arrangements were tested. Particular emphasis was placed on practical aspects of reactor/engine operation. This work follows earlier work with a 4 kW shaft power output system using charcoal-derived producer gas. (author).

0930 Economic, Industrial, and Business Aspects

Refer also to citation(s) 25628

25631 (IEACG–CE02992) **Wood heating of Canadian homes. Summary of the conclusions of the national survey on the feasibility of wood heating.** IEA Consulting Group Ltd., Charlottetown, PE (Canada). [1990]. 24p. (CE–02992). Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

This study, intended for people in the public and private sectors who are interested in wood as an alternative to more common fuels for residential heating, sumarizes the results fo a survey made in 1983 for the Canadian ministry of Energy, Mines and Resources. The survey methods are outlined. The importance of domestic wood heating is discussed. 38% of Canadians, or 3 million of Canadian families burn wood for heating or for pleasure. The report discusses the volume of more common fuels which are being displaced by wood fuels, the savings associated with wood heating, the social characteristics of wood-burning families, wood procurement, and the installation and operation of wood-burning equipment. The motivations of the people who burn wood are reviewed. In conclusion, wood heating is a feasible alternative for many Canadian families. 1 fig., 19 tabs.

25632 (PNL-SA–17859) **Wood heating behavior and electrical displacement for a sample of homes in the Pacific Northwest.** LeBaron, B.A. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 7p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. (CONF-900315–1: Solar '90: 19th American Solar Energy Society annual conference, Austin, TX (USA), 18-20 Mar 1990). Order Number DE90009175. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper examines wood heating in a sample of homes in the Pacific Northwest as part of the End-Use Load and Consumer Assessment Program (ELCAP). ELCAP is operated by Pacific Northwest Laboratory under the direction of the Bonneville Power Administration for the purpose of improving electrical power load forecasting capabilities. Wood device operation and electrical space heating were monitored at each site by a microprocessor-controlled data logger. This allowed precise knowledge of the electrical consumption and frequency of wood use with high temporal resolution. Wood burning behavior showed a frequency and duration that increased predictably as a function of decreasing outside temperature. During the coldest months of the heating season the sample of wood users had a strong bimodal distribution, with a group that burned wood almost daily and a group that rarely burned wood. Diurnal profiles of wood use were qualitatively similar to those observed for electrical space heating with peaks in the morning and evening hours. The electrical load displaced by wood heating was estimated using analysis of individual sites and averages across the sample. For the sample of wood heating homes, the mean electrical displacement was 31% of the heating load for the 1985/1986 heating season. 8 refs., 6 figs.

0950 Environmental Aspects

Refer also to citation(s) 26783

0980 Waste Management

25633 (ADI–CE02988) **Regional determination of economic availability of harvesting residues.** Adi Ltd., Fredericton, NB (Canada). 1984. vp. (CE–02988). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report presents a survey of the technology, fuel supply, environmental issues and economic related to the use of forest harvest residues as fuel in New Brunswick. A study to determine the quantities of forest residues available in the Miramichi drainage system in New Brunswick showed that for each 1,000 hectares of typical mature forest harvested, there would be 46,875 tonnes (over-dry basis) of forest residues available each year, their average moisture content being 38%. This corresponds to 375,000 tonnes/y for the whole region. The amount of residue developed during any harvesting operation is not affected by the logging method used, but the location of the slash is. Although advances are being made in the design of residential heating systems for buring chipped wood, institutions and large industries such as pulp mills are more likely to be the chief outlets for this fuel. The market in and around the region was estimated to be 241,000 tonnes/y. Costs of whole-tree wood chips are shown to be substantially lower than the cost of residue. The competitive value of wood fuel at roadside with respect to fuel oil is discussed. The removal of the residues is generally thought to have a small negative environmental impact compared to the original cutting operation; on the other hand, the fire hazard is decreased and the conditions of replanting are improved. It is recommended that an evaluation of conversion to wood fuel at specific locations in the province be undertaken. The report also contains a discussion of the world supply and demand for wood based fuel chips and its incidence in New Brunswick. A short glossary of terms pertaining to wood harvesting is provided. 42 refs., 34 figs., 25 tabs.

25634 (AMC–1192) **Feasibility of constructing a potato-based ethanol plant in New Brunswick.** Applied Management Consultants, Fredricton, NB (Canada). Apr 1989. 61p. (MICROLOG–89-06377). Available from PC New Brunswick Legislative Library, Government Documents Section, 766 King Street, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines

and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The demonstration plant of the Alcell process which is built in Newcastle by Repap Inc. should consume 1.6 M gal/y of ethanol. If part or all of this ethanol were produced from potato wastes, the revenue of the potato producers would increase and the amount of potato waste would decrease. The technology for producing ethanol from starch-bearing substances is reviewed. Two plants in the USA are presently producing ethanol from potato wastes and the feasibility of such a plant in New Brunswick depends on the supply cost of potato wastes. A plant which would be sufficiently large to produce 1.6 M gal/y would need about 130,000 tonnes/y of potato wastes. This amount, priced at $12.1/tonne, could be produced by New Brunswick producers within a few years. However, potato wastes could also be obtained from Maine producers. The seasonal variation of the potato wastes supply, the costs and the benefits of the projected ethanol plant are discussed. To be profitable, such a plant would need financial help. It should be designed for a capacity of 2 M gal/y, and have access to an affordable supply of potato wastes during 7 to 9 months per year. It should require access to APECA subsidies, be located near to a potato wastes producer, and have a secure market for the produced ethanol. The only competitor of the Alcaell demonstration plant is Commercial Alcohols of Montreal. The ethanol plant will, therefore, have to offer competitive prices. A long-term contract as to supply part of the demand of the Alcell plant could strengthen the prices the Canadian market is currently over-supplied, the surplus is currently exported to the United States. The report also recommends that an environmental impacts assessment of the project be made. 18 tabs.

25635 (NBES–2024) **Woodchip fuel boiler conversion, Brookdale Nurseries, Newcastle, N.B.** New Brunswick Energy Secretariat, Fredericton, NB (Canada). Dec 1984. 50p. (CE–02960). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The wood chip burner demonstration at Brookdale Nurseries, Newcastle, New Brunswick greenhouses, was implemented with the primary objective of reducing the energy costs by converting a boiler from fuel oil to wood chip burning, utilizing wood residue from local sources. Partial funding for the project was provided by the Conservation and Renewable Energy Demonstration Agreement. Tests were performed during the 1983-1984 heating season to determine the performance of the owner-fabricated Dutch Oven burner retrofitted to a previously oil-fired, 250 hp boiler. The overall fuel comsumption during the seven month monitoring period was 420 tonnes of 20% wet basis wood chips. The total production of low pressure (40 kPa) steam was 2,1000 tonnes from condensate supplied to the boiler at about 30 C. Measurements of the heat efficiency of the system indicated 71% to 79% using the stack loss method, and 69.5% to 84.8% using the ratio of output energy to input energy. The system operated at a smoke number of 1, at which there were no visible emissions. The boiler was found to be fired at 20-22% of its capacity, which output is matched by a similarly low output from the Dutch Oven burner relative to its capacity. However, modifications to the fuel feeding system to the burner and, possibly, to the combustion air supply sytem should make possible a large increase in the steam output from this burner/boiler combination. The entire system has performed well, and has produced a operating cost saving of about 70% when compared to the previous oil installation. Payback was achieved in 1.9 y. The automation of the system has made it a very easy system to operate, and virtually worry-free. The project has served as a demonstration. 4 refs., 3 figs., 8 tabs.

25636 (NBNRE/FM–89-05617) **Wood chip heating for residential and other small buildings: Characteristics and operation of the heating system and small-scale manufacture of fuel.** Hermelin, J. (Ministere des Ressources Naturelles, Province du Nouveau-Brunswick, NB (Canada)); Schneider, M.H.; Short, C.A. New Brunswick Dept. of Natural Resources and Energy, Fredericton, NB (Canada). Feb 1983. 120p. Contract EMR 23380-2-6900. (MICROLOG–89-05617). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

It is possible to obtain good quality wood chips from forest wastes for a relatively small price. This kind of fuel can be utilized easily, cleanly and efficiently in variour types of heating devices. The Scandinavian experience of using wood chips as fuel is outlined. Wood chip burning furnances and reheaters are described along with their feeding systems (hopper and/or Archiwedean screw). The choice, installation, operation and maintenance of the devices are discussed, and the methods of measuring combustion efficiency and of choosing the optimum air-to-fuel ratio (as a function of the moisture content of the chips) are presented. Fire safety and fire hazards insurance are underlined as are the health problems associated with dust and molds. Forest growing and cutting and are discussed, as are the methods of drying and storing the chips. One tonne of wood chips with 20% moisture content replaced 442 litres of fuel oil; in another Fredericton house using a hot-water furnace and providing the domestic hot water, the same amount of wood chips replaced 416 litres of fuel oil. The costs of wood chip heating are summarized. A glossary of technical terms (in French) is provided.

0990 Products and By-Products

Refer also to citation(s) 25626

10 SYNTHETIC FUELS

1002 Production

Refer also to citation(s) 25288, 26237

25637 (CRIQ–MAT-88-029) **Manufacture of hydrocarbons on nickel-bearing magnetite based catalysts according to Fischer-Tropsch synthesis: Final report.** Centre de Recherche Industrielle du Quebec, Sainte-Foy, PQ (Canada). Mar 1988. 120p. Contract EMR 03-SQ.23440-609045. (MICROLOG–89-06221). Available from PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report is in support of a feasibility study on the conversion of synthesis gas into Diesel fuel with a catalyst-based on nickel-bearing magnetite from asbestos mine tailings. The mineralogy and physico-chemical properties of the asbestos tailings from Eastern Quebec and of the derived catalysts (CL-13) are discussed. The chemical reactor system is described and the results of the Fischer-Tropsch tests are presented. The behavior of the catalyst (preactivation, high-temperature oxidation, and formation of a carbon deposit), the conversion ratio and the selectivity of the reaction are discussed. The results obtained are compared with those of other known catalysts of the Fischer-Tropsch synthesis. It is believed that CL-13 could also be used as a catalyst for the Kobbel-Engelhardt reaction and for the removal of carbon monoxide in the purification of hydrogen. 44 refs., 22 figs., 24 tabs.

25638 (EPRI-GS–6219, pp. 2.3-2.9) **Biomimetic catalysis.** Fish, R.H. (Lawrence Berkeley Lab., CA (USA)); Fong, R.H.; Price, R.T.; Vincent, J.B.; Christou, G. Electric Power Research Inst., Palo Alto, CA (USA). Jan 1989. DOE Contract AC03-76SF00098. (CONF-8805259–: 13. annual EPRI conference on fuel science and conversion, Santa Clara, CA (USA), 18-19 May 1988). In *Thirteenth annual EPRI conference on fuel science and conversion.* Order Number DE89006673. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Metal complexes that mimic the active site of monooxygenase enzymes and convert carbon-hydrogen bonds to carbon-hydroxyl in the presence of a monooxygen transfer reagent are called biomimetic catalysts. Studies concerning the activation of methane, ethane, propane, and cyclohexane to their respective alcohols with biomimetic catalysts that encompass manganese and iron supramolecule porphyrins and open-faced porphyrins; manganese

and iron non-porphyrin di, tri, and tetranuclear clusters; and manganese mononuclear substituted Keggin ions in the presence of iodosylbenzene and t-butyl hydroperoxide are discussed.

25639 (EPRI-GS–6219, pp. 5.3-5.15) **Bench-scale/laboratory result - Novel methanol catalyst.** Mahajan, D. (Brookhaven National Lab., Upton, NY (USA)); Sapienza, R.S.; O'Hare, T.E. Electric Power Research Inst., Palo Alto, CA (USA). Jan 1989. (CONF-8805259–: 13. annual EPRI conference on fuel science and conversion, Santa Clara, CA (USA), 18-19 May 1988). In *Thirteenth annual EPRI conference on fuel science and conversion.* Order Number DE89006673. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The catalytic conversion of synthesis gas into methanol has been achieved at low temperature and low pressure using a novel liquid phase catalyst (FAST-M) developed at Brookhaven National Laboratory (BNL). The catalyst consisting of two simple components dissolved in methanol and a cosolvent permits >90% gas conversion per pass with balanced gas in batch-mode with high selectivity, typically >95%, to methanol. The performance of the catalyst under continuous flow conditions is now being tested on a bench-scale demonstration unit. Several runs, of up to 8-hour duration, have been carried out at 110°-130°C and 185-365 psia containing 7.0% by weight catalyst in methanol-glyme solvent. Per pass CO conversions of up to 74% and methanol productivities of up to 45 g-mol MeOH/kg. cat-hr have been achieved. Of interest is the utilization of CO rich feed gas (CO/H_2=1) with the new catalyst. Runs are underway to achieve the highest possible per pass gas conversions on the unit. A kinetic model for the system is being developed. The unit modification to include catalyst recycle is planned. Based on these data, a 60 Liters/day pilot plant scale-up is envisioned.

13 HYDRO ENERGY

1301 Resources and Availability

25640 (BCH/ESSOMD–118) **Williston Reservoir raising - environmental overview.** British Columbia Hydro, Vancouver, BC (Canada). Environmental Services, System Operations and Maintenance Div. Jul 1988. 120p. (MICROLOG–90-01770). Available from PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This preliminary environmental overview report was prepared by B.C. Hydro in June 1987 and revised in July 1988 as an initial assessment of a possible 1.5 m (5 ft.) raise in the Williston Reservoir maximum normal level. The enviromental overview study and the associated engineering and property studies were undertaken to provide information for a decision on whether to initiate more detailed studies. Overview studies are based mainly on available reports, mapping and field data, supplemented by limited site reconnaissance and, in this case, input from key agencies and groups. The lack of adequate mapping of areas which could be affected by reservoir raising did not permit definitive conclusion to be reached. This mapping will be done over the next year to complete the overview assessment. This document covers the impact assessment of socio-economic factors, forestry, reservoir clearing, heritage, recreation, aquatic resources, and wildlife. Further studies in each of these areas are also included. 54 refs., 11 figs., 8 tabs.

25641 (EC/IWD–90-00293) **Surface water data, Saskatchewan 1988.** Environment Canada, Ottawa, ON (Canada). Inland Waters Directorate. 1989. 200p. (MICROLOG–90-00293). Available from PC Environment Canada, Library Services, Terrasses de la Chaudiere, 10 Wellington St., Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A summary is presented of daily water level or discharge, monthly and annual mean water levels, and monthly and annual discharge information (total, mean value, and maximum and minimum values) at locations on lakes and rivers in Saskatchewan. Data have been collected for the year 1988 by the Water Survey of Canada. Descriptive information about the gauging station is also included, such as location, data collection method (manual gauge, water-stage recorder, or records obtained by using the latest available rating of the associated hydroelectric power plant), ice conditions, drainage area, and whether the flow is natural or regulated.

25642 (EC/IWD–90-00296) **Surface water data, Alberta 1988.** Environment Canada, Ottawa, ON (Canada). Inland Waters Directorate. 1989. VP (MICROLOG–90-00296). Available from PC Environment Canada, Library Services, Terrasses de la Chaudiere, 10 Wellington St., Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A summary is presented of daily water level or discharge, monthly and annual mean water levels, and monthly and annual discharge information (total, mean value, and maximum and minimum values) at locations at lakes and rivers in Alberta. Data have been collected for the year 1988 by the Water Survey of Canada with contributions by other federal and provincial organizations and private companies, including utilities. Descriptive information about the gauging stations is also included, such as location, data collection method (manual gauge, water-stage recorder, or records obtained by using latest available rating of the associated power plant), ice conditions, drainage area, and whether the flow is natural or regulated.

25643 (EC/IWD–90-00330) **Surface water data, Manitoba 1988.** Environment Canada, Ottawa, ON (Canada). Inland Waters Directorate. 1989. 196p. (MICROLOG–90-00330). Available from PC Environment Canada, Library Services, Terrasses de la Chaudiere, 10 Wellington St., Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A summary is presented of daily water level or discharge, monthly and annual mean water levels, and monthly and annual discharge information (total, mean value, and maximum and minimum values) at locations on lakes and rivers in Manitoba. Data have been collected for the year 1988 by the Water Survey of Canada with contributions by other federal, provincial, and municipal organizations and private companies (including hydroelectric utilities). Descriptive information about the gauging stations is also included, such as location, data collection method (manual gauge, water-stage recorder. or records obtained by using latest available rating of the associated power plant), ice conditions, drainage area, and whether the flow is natural or regulated.

25644 (EC/IWD–90-00341) **Surface water data, British Columbia 1988.** Environment Canada, Ottawa, ON (Canada). Inland Waters Directorate. 1989. 317p. (MICROLOG–90-00341). Available from PC Environment Canada, Library Services, Terrasses de la Chaudiere, 10 Wellington St., Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A summary is presented of daily water level or discharge, monthly and annual mean water levels, and monthly and annual discharge information (total, mean value, and maximum and minimum values) at locations on lakes and rivers in British Columbia. Data have been collected for the year 1988 by the Water Survey of Canada with contributions by the provincial environment ministry, the British Columbia Hydro and Power Authority, and private companies. Descriptive information about the gauging stations is also included, such as location, data collection method (manual gauge, water-stage recorder, or records obtained by using latest available rating of the associated power plant), ice conditions, drainage area, and whether the flow is natural or regulated.

25645 (EC/WID–90-00294) **Surface water data, Atlantic provinces 1988.** Environment Canada, Ottawa, ON (Canada). Inland Waters Directorate. 1989. 209p. (MICROLOG–90-00294).

Available from PC Water Survey of Canada, Place Vincent Massey, 351 St. Joseph Blvd., Ottawa, ON, CAN K1A 0E7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

A summary is presented of daily water level or discharge, monthly and annual mean water levels, and monthly and annual discharge information (total, mean value, and maximum and minimum values) at locations on lakes and rivers in Newfoundland and Labrador, Prince Edward Island, Nova Scotia, and New Brunswick. Data have been collected for the year 1988 by the water Survey of Canada with contributions by other federal and provincial organizations and private companies, including electric utilities. Descriptive information about the gauging stations is also included, such as location, installation or method used for data collection, ice conditions, drainage area, and whether the flow is natural or regulated.

1303 Plant Design and Operation

25646 (BCME/CT–CE02956) **Glacier Park small hydro demonstration: Project evaluation report.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). Conservation and Renewable Energy Branch; British Columbia Ministry of Energy, Mines and Petroleum Resources, Vancouver, BC (Canada). Conservation and Technology Div. Jan 1984. 9p. (CE–02956). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN.

This facility, located in the Glacier National Park, provides electric power for the Glacier Park Lodge, which requires 100 kVA, previously produced solely by a 671 Diesel-generator set. Also, the excess power is to be utilized in the form of heat to supplement the output of the lodge's oil furnances, which provide domestic and heating hot water. The flow of water in Connaught Creek as a function of the season of the year is discussed. The facility is described: penstock (64 m 380 l/s) head, power-house (Pettech 150kW Pelton stainless steel turbine and KATO 600V, 3 phrase, 150 kVA generator with belt drive), the innovative automatic control system, and the monitoring equipment. The problems encountered during the first months of operation are summarized. The most serious were due to the harsh winter conditions and to the crowding of the penstock intake by debris. The benefits of this project include: the acquisition of technical experience by the suppliers; the reduction in fossil fuel consumption, both in power generation and in heating; and the revitalization of the trees and foliage surrounding the diesel plant after it was shut down; as well as an ending to the noise pollution emanating from the plant. The total savings during the first 5 months of operation have been 57,796 liters of Diesel fuel, or Canadian $18,206, but the capital costs are not indicated. No negative environmental effects have been observed yet. Since its inception and since the beginning of the construction of the facility, in October 1982, this project has drawn considerable attention from individuals and from the industry. 3 figs., 3 tabs.

25647 (BCME/CT–CE02957) **Nimmo Bay small hydro project report.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). Conservation and Renewable Energy Branch; British Columbia Ministry of Energy, Mines and Petroleum Resources, Vancouver, BC (Canada). Conservation and Technology Div. Mar 1984. 7p. (CE–02957). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

A 35 kilowatt hydroelectric system was installed at Nimmo Bay Resort, a fishing and tourist resort on the north central coast of British Columbia. Nimmo Bay Resort accommodates 8 to 12 guests seasonally (June - September) plus a family of 6 year-round. The purpose of the project was to demonstrate the technical and financial viability of small hydro for a remote commercial operation. The report describes the system, including the 240 m long, 64 m head polyvinyl chloride penstock and the Pelton wheel, the installation of the system with the help of a barge and a helicopter, and the operational problems encountered: phase imbalance, power surges and lubrication problems. The cost of the project was estimated to be $51,000, which covered the equipment and materials, supplier's installation costs, and imformation transfer. The capital cost of the installation was approximately Canadian $46,000, not including the resort owner's substantial amount of labour. The Canada/British Columbia conservation and Renewable Energy Demonstration Agreement contributed Canadian $12,600 and Nimmo Bay Resort provided the remainder of the funds. The estimated first year saving in diesel fuel was $11,200 and, in addition, the estimated saving in diesel system maintenance was Canadian $1,350 for the total first-year saving of Canadian $ 12,550. The system has proven capable of displacing most, but not all, of the diesel requirements. The operation of the system requires participation by the owners in maintenance and repairs. 3 figs., 1 tab.

25648 (DOE/RA/23212–4) **Bolton Falls Hydroelectric Redevelopment Project: Final operation and maintenance report: Small-Scale Hydroelectric Power Demonstration Project.** Green Mountain Power Corp., Burlington, VT (USA). Jun 1989. 51p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC07-79RA23212. Order Number DE90007962. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report provides a final accounting of the operation and maintenance costs from the first two year of operation of the Hydroelectric Demonstration Project located in Duxbury, Vermont. Prior to construction, Green Mountain Power (GMP) executed a Cooperative Agreement with the US Department of Energy (DOE) Number FC07-79RA23212 which contributed $2,621,609 toward the construction of the facility. A separate report covering the design, technical, construction, legal, institutional, environmental and other related aspects of the total project was furnished to DOE previously for publication as the "Final Technical and Construction Cost Report" dated March 3, 1988. This report discusses GMP's operating experience with the units as well as operation and maintenance costs for the first 24 months of operation. 8 figs., 4 tabs.

1304 Legislation and Regulations

Refer also to citation(s) 25649

1305 Economic, Industrial and Business Aspects

Refer also to citation(s) 25920, 25925

1306 Environmental Aspects

Refer also to citation(s) 25640

25649 (DOE/BP/12660–5) **Quantification of Libby Reservoir levels needed to maintain or enhance reservoir fisheries: Methods and data summary, 1983–1987.** Chisholm, I. (Montana Dept. of Fish, Wildlife and Parks, Kalispell, MT (USA)); Hensler, M.E.; Hansen, B.; Skaar, D. USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife; Montana Dept. of Fish, Wildlife and Parks, Kalispell, MT (USA). Feb 1990. 273p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract BI79-83BP12660. Order Number DE90009377. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

Libby Reservoir was created under an International Columbia River Treaty between the United States and Canada for cooperative water development of the Columbia River Basin. The authorized purpose of the dam is to provide power, flood control, and navigation and other benefits. Research began in May 1983 to determine how operations of Libby dam impact the reservoir fishery and to suggest ways to lessen these impacts. This study is unique in that it was designed to accomplish its goal through detailed information gathering on every trophic level in the reservoir system and integration of this information into a quantitative computer model. The specific study objectives are to: quantify available reservoir habitat, determine abundance, growth and distribution of fish within the reservoir and potential recruitment of salmonids from Libby Reservoir tributaries within the United States, determine abundance and availability of food organisms for fish in the reservoir, quantify fish use of available food items, develop relationships between reservoir drawdown and reservoir habitat for fish and fish food organisms, and estimate impacts of reservoir operation on the reservoir fishery. 115 refs., 22 figs., 51 tabs.

25650 (DOE/EA–0414) **The Dalles Dam North Fishway Hydroelectric Project: Environmental Assessment.** USDOE Bonneville Power Administration, Portland, OR (USA). Dec 1989. 25p. Sponsored by U.S. DOE Management & Administration. Order Number DE90008994. Available from NTIS, PC A03/MF A01 - OSTI.

The Northern Wasco County People's Utility District filed an application for major license, for the Dalles Dam North Fishway Hydroelectric Project. The proposed project would be built at the north end of the existing Dalles dam, operated by the Department of the Army, Portland District Corps of Engineers (Corps). The dam is located on the Columbia river, near the town of the Dalles, Oregon. The proposed project would be located on the auxiliary water supply system for the north fishway at the dam. The Corps operates the dam for flood control, navigation, power production, and fish passage. The proposed project would affect federal property administered by the Corps. 13 refs., 2 figs.

14 SOLAR ENERGY

1405 Solar Energy Conversion

Refer also to citation(s) 25673, 26347, 26355, 26356, 26358

25651 (PB–90-142266/XAB) **Economic benefits of the marine biomass program at GRI (Gas Research Institute.) Annual report, September 1982-June 1983.** Haas, S.M.; Marshalla, R.A.; Nesbitt, D.M.; Oman, D.B. Decision Focus, Inc., Los Altos, CA (USA). 1983. 60p. Available from NTIS, PC A04/MF A01.

See also report No. 4, PB–90-142258.

The overall economic benefits that will occur if marine biomass is successful are substantial; however the probability of achieving those benefits is assumed by GRI to be relatively small. Using a five percent real discount rate, the value of overall economic benefits if marine biomass succeeds rather than fails is 42.69 billion dollars. The benefits specifically attributable to GRI, using a five percent real discount rate and GRI's existing activities in marine biomass, is 7.88 billion dollars. GRI's R&D activities can achieve roughly 18 percent of the maximum possible expected benefits.

25652 (SERI/TP–211-3656) **Improvement of small-area, amorphous-silicon thin-film photovoltaics on polymer substrate: Final subcontract report, 1 March 1988–30 June 1989.** Weber, M.F. (Minnesota Mining and Mfg. Co., St. Paul, MN (USA). Applied Technologies Lab.). Solar Energy Research Inst., Golden, CO (USA); Minnesota Mining and Mfg. Co., St. Paul, MN (USA). Applied Technologies Lab. Feb 1990. 30p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90000314. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes a contract to produce, using roll-to-roll deposition on polyamide substrate, a small-area amorphous-silicon p-i-n photovoltaic (PV) cell with an energy conversion efficiency of 10% under air mass 1.5 insolation. Three improvements were attempted to achieve this goal: (1) zinc oxide, a transparent conducting oxide, was used as a top contact; the zinc oxide conductivity was improved to 8–9 ohms/square sheet resistance with less than 8% average optical absorption. (2) The red light response was improved with dielectric enhanced metal reflecting electrodes, which increased the short-circuit current density by more than 1 mA/Cm^2; a three-layer dielectric mirror coating was also designed that can increase the current density by another 1 mA/cm^2. (3) Improving the fill factor of the n-i-p (reverse structured) devices was also achieved in a multichamber deposition system. The overall energy conversion efficiency of the PV cell was 8.36%. Major obstacles to higher efficiencies are (1) controlling the thin-film defects that cause electrical shunts in devices fabricated on enhanced reflection electrodes, and (2) controlling impurities and introducing dopant profiles near the p/i interface in a continuous web deposition system.

25653 (SERI/TP–211-3667) **Research on amorphous silicon-based thin film photovoltaic devices: Task B, Research on stable high efficiency large area, amorphous silicon-based submodules: Semi-annual subcontract report, 16 March 1989–30 November 1989.** Delahoy, A.E. (Chronar Corp., Princeton, NJ (USA)); Ellis, F.B.; Kothandaraman, C.; Schade, H.; Tonon, T.; Weakliem, H. Solar Energy Research Inst., Golden, CO (USA); Chronar Corp., Princeton, NJ (USA). Mar 1990. 38p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90000320. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The primary objective of this subcontract is to develop amorphous silicon p-i-n/p-i-n tandem junction photovoltaic submodules (>900 cm^2) having an aperture area efficiency of at least 9%. A further objective is to demonstrate 8% tandem submodules that degrade by no more than 5% under standard light soaking conditions. The main lines of investigation during this period concerned with exploration of novel types of p-layers, the properties and applications of doped zinc oxide films to a–Si:H cells, the effects of various surface treatments of SnO_2 and ZnO transparent conducting oxides (TCO's) on cell performance, the dependence of cell stability on substrate and junction type, and the development of techniques to enable the full potential performance of the a–Si:H to be realized in a module configuration. 12 refs., 11 figs., 13 tabs.

25654 Thin film photovoltaics. Zweibel, K. (Solar Energy Research Inst., Golden, CO (USA)); Ullal, H.S. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899558.

Thin films are considered a potentially attractive technological approach to making cost-effective electricity by photovoltaics. Over the last twenty years, many have been investigated and some (cadmium telluride, copper indium diselenide, amorphous silicon) have become leading candidates for future large-scale commercialization. This paper surveys the past development of these key thin films and gives their status and future prospects. In all cases, significant progress toward cost-effective PV electricity has been made. If this progress continues, it appears that thin film PV could provide electricity that is competitive for summer daytime peaking power requirements by the middle of the 1990s; and electricity in a range that is competitive with fossil fuel costs should be available from PV around the turn of the century.

25655 Mimicking photosynthesis. Gust, D. (Arizona State Univ., Tempe (USA)); Moore, T.A. *Science (Washington, D.C.) (USA)*, 244(4900): 35-41 (7 Apr 1989). DOE Contract FG02-88ER13969.

Although the concept of an artificial photosynthetic reaction center that mimics natural electron- and energy-transfer processes is an old one, in recent years major advances have occurred. In this review, some relatively simple molecular dyads that mimic certain aspects of photosynthetic electron transfer and singlet or triplet energy transfer are described. Dyads of this type have proven to be extremely useful for elucidating basic photochemical principles. In addition, their limitations, particularly in the area of temporal stabilization of electronic charge separation, have inspired the development of much more complex multicomponent molecular devices. The use of the basic principles of photoinitiated electron transfer to engineer desirable properties into the more complex species is exemplified. The multiple electron-transfer pathways available with these molecules make it possible to fine-tune the systems in ways that are impossible with simpler molecules. The study of these devices not only contributes to our understanding of natural photosynthesis, but also aids in the design of artificial solar energy harvesting systems and provides an entry into the nascent field of molecular electronics. 38 refs., 4 figs.

1406 Photovoltaic Power Systems

25656 (ADS–55-046) **Survey report on the ingrafting of photo-voltaic technology within the federal government.** ADS Associes Limitee, Groupe-Conseil (Canada). Apr 1989. 30p. (MICROLOG–89-05651). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and

Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A study on the utilization of photovoltaic technology (PVT) as a power source within the federal government of Canada has shown that, in some ministries and organizations, this technology is solidly ingrafted; conversely, it has shown that, in other federal ministries, there is a resistance to the penetration of this technology as an energy source. The cases of Communications, Transport, National Defense, the Royal Canadian Mounted Police, Public Works, Environment, and Indian Affairs are reviewed. To overcome or attenuate the obstacles to PVT penetration remedial measures have been proposed which are adapted to the PVT utilization context of each ministry. These measures are subdivided into 5 categories comprising research and development projects, the implementation of the sponsoring of some ministries by others, imformation dissemination, the implementation of a central data base accessible by all the ministries, and, finally, demonstration projects in existing plants. 1 fig., 1 tab.

25657 (DOE/AL/42558–T1) **Massachusetts photovoltaic program: Technical progress report.** Massachusetts Executive Office of Consumer Affairs and Business Regulation, Boston, MA (USA). Div. of Energy Resources. 15 Apr 1989. 11p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC04-87AL42558. Order Number DE90008283. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Changes in the cooperative agreement were approved. Under the changes the University of Lowell Photovoltaic Program will begin an evaluation of batteries for photovoltaic applications and will monitor Massachusetts Photovoltaic Utilization Program projects. The grain drier, water pump, and refrigerator project are concluding.

25658 (EPRI-EL–6754-Vol.1) **Photovoltaic generation effects on distribution feeders: Volume 1, Description of the Gardner, Massachusetts, twenty-first-century PV community and research program: Final report.** Electric Power Research Inst., Palo Alto, CA (USA); New England Power Service Co., Westborough, MA (USA); Ascension Technology, Lincoln Center, MA (USA); Electric Research and Management, Inc., State College, PA (USA); Worcester Polytechnic Inst., MA (USA). c Mar 1990. 46p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

As the electric utility industry looks to diversify and expand its energy mix, more and more attention is being focused on alternate energy sources such as roof-mounted photovoltaic (PV) generation systems. The principal objective of this research project is to determine if present designs for distributed photovoltaic generation equipment will operate without detrimental effect on either the utility system or the customer owned equipment. Grid-connected, roof-mounted photovoltaic (PV) systems have been installed by the New England Electric system Companies on 30 houses in Gardner, Massachusetts. Each installation includes a 2 kW inverter to convert the dc output of the PV array to 240 V ac thus permitting a direct connection to the house electrical distribution panel. Selection of the houses comprising the Gardner Model PV Community was predicated on establishing a high saturation of inverters as may become typical on New England distribution feeders in the next century. Accordingly, all 30 PV houses are in one neighborhood on the very end of one phase of a 13.8 kV feeder. 19 figs., 1 tab.

25659 A nickel/hydrogen battery for solar applications. Bush, D.M. (Sandia National Labs., Albuquerque, NM (USA)); Sindorf, J.F. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 3. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899148.

The nickel/hydrogen battery was developed for energy storage in communication satellites. Advantages offered by this battery include long life, low maintenance, and high reliability. These attributes would also he desirable for terrestrial applications, but the cost of aerospace technology is prohibitively high. Work has been conducted over the past several years to reduce the cost. The authors present a battery consisting of prismatic cells in a common pressure vessel which has evolved from this work. It is currently being evaluated in a series of solar tests using a photovoltaic array for charging.

1407 Solar Thermal Power Systems

Refer also to citation(s) 25666

25660 (CANWEC–CE02833 Report 3.1.10) **A financial models for large scale solar power systems: Report 3.1.10.** Francois, P. (Luz International Ltd. (Canada)); Pinto, J.; Zilka, Y.; Lipsky, L. Canadian National Committee, World Energy Conference, Ottawa, ON (Canada). 1989. (CONF-890901–: 14. world energy conference, Montreal (Canada), 17-22 Sep 1989; CE–02833). In *Energy for tomorrow. Division 3: Energy and the economy: Session 3.1: International aspects of energy economics.* Available from Canadian National Committee World Energy Conference, Suite 305, 130 Albert Street, Ottawa, ON, CAN K1P 5G4. Prices: $125.00 CAN.

Luz International Limited, a California based corporation, is developer, designer, manufacturer and builder of large scale solar electric generating systems(SEGS). SEGS are Rankine steam cycle electric plants whose primary energy source is the sun. A modular field of line-focus parabolic trough collectors concentrates the sun's thermal energy and transfers it to state-of-the-art steam generation equipment. The solar thermal energy is collected and transferred through a synthetic heat transfer fluid which is heated to relatively high temperatures. The system usually also has the capability to burn a fossil fuel in parallel to the use of solar energy. One way to overcome the hesitation of utilities to engage in SEGS, particularly in developing countries, consists in the development of a financial model for building and operating solar power plants through independent third parties. This paper describes a SEGS project organizational struture, the role of the participants, incentives and investment, project financing and economic advantages of the model.

25661 (FRNC-TH–3572) **Themis solar plant annual performance evaluation. Comparison of performances from various solar plants.** Izygon, M. Ecole Centrale des Arts et Manufactures, 92 - Chatenay-Malabry (France). 1987. 200p. (In French). Order Number DE90770645. Available from NTIS (US Sales Only), PC A09/MF A01.

The experimental results obtained during various types of day and daylighting, showed that the response of a tower type solar plant is represented by a characteristic curve with an elbow shape. A model is developed that confirms the experimental results, related to different parameter and in particular with the meteorological parameters of the area. The energetic potential can be calculated with a good relative precision. The performances of Themis, solar one and sunshine are then compared.

25662 (N–90-14283) **A heat receiver design for solar dynamic space power systems.** Baker, K. W.; Dustin, M. O.; Crane, ROGER. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1990. 7p. (NASA-TM–102473;E–5253;NAS–1.15:102473;CONF-900449–: ASME international solar energy conference, Miami, FL (USA), 1-4 Apr 1990). Available from NTIS, PC A02/MF A01.

An advanced heat pipe receiver designed for a solar dynamic space power system is described. The power system consists of a solar concentrator, solar heat receiver, Stirling heat engine, linear alternator and waste heat radiator. The solar concentrator focuses the sun's energy into a heat receiver. The engine and alternator convert a portion of this energy to electric power and the remaining heat is rejected by a waste heat radiator. Primary liquid metal heat pipes transport heat energy to the Stirling engine. Thermal energy storage allows this power system to operate during the shade portion of an orbit. Lithium fluoride/calcium fluoride eutectic is the thermal energy storage material. Thermal energy storage canisters are attached to the midsection of each heat pipe. The primary heat pipes pass through a secondary vapor cavity heat pipe near the engine and receiver interface. The secondary vapor cavity heat pipe serves three important functions. First, it smooths out hot spots in the solar cavity and provides even distribution of heat to

the engine. Second, the event of a heat pipe failure, the secondary heat pipe cavity can efficiently transfer heat from other operating primary heat pipes to the engine heat exchanger of the defunct heat pipe. Third, the secondary heat pipe vapor cavity reduces temperature drops caused by heat flow into the engine. This unique design provides a high level of reliability and performance.

25663 (N–90-14285) **On protection of Freedom's solar dynamic radiator from the orbital debris environment. Part 1. Preliminary analyses and testing.** Rhatigan, J.L.; Christiansen, E.L.; Fleming, M.L. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1990. 10p. (NASA-TM–102458;E–5245;NAS–1.15:102458;CONF-900449–: ASME international solar energy conference, Miami, FL (USA), 1-4 Apr 1990). Available from NTIS, PC A02/MF A01.

A great deal of experimentation and analysis was performed to quantify penetration thresholds of components which will experience orbital debris impacts. Penetration was found to depend upon mission specific parameters such as orbital altitude, inclination, and orientation of the component; and upon component specific parameters such as material, density and the geometry particular to its shielding. Experimental results are highly dependent upon shield configuration and cannot be extrapolated with confidence to alternate shield configurations. Also, current experimental capabilities are limited to velocities which only approach the lower limit of predicted orbital debris velocities. Therefore, prediction of the penetrating particle size for a particular component having a complex geometry remains highly uncertain. An approach is described which was developed to assess on-orbit survivability of the solar dynamic radiator due to micrometeoroid and space debris impacts. Preliminary analyses are presented to quantify the solar dynamic radiator survivability, and include the type of particle and particle population expected to defeat the radiator bumpering (i.e., penetrate a fluid flow tube). Results of preliminary hypervelocity impact testing performed on radiator panel samples (in the 6 to 7 km/sec velocity range) are also presented. Plans for further analyses and testing are discussed. These efforts are expected to lead to a radiator design which will perform to requirements over the expected lifetime.

1409 Solar Thermal Utilization

25664 (BCME/CT–CE02890) **Solar heating at University of Victoria's McKinnon Building.** British Columbia Ministry of Energy, Mines and Petroleum Resources, Vancouver, BC (Canada). Conservation and Technology Div. [1990]. 15p. (CE–02890). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

A large solar installation, including 4,200 square feet of collectors, was installed in February 1982 at the McKinnon Building, an athletics facility at the University of Victoria. The performance of the system was monitored, using Rho Sigma BTU meters, pyranometer, kilowatt-hour meter and thermometers, and the first year's results are presented here. The system heats water for the showers, change rooms and indoor swimming pool. The installation is a Solarsystems Industries drain-down type, using single glazed collectors with selective coated absorbers. No solar storage is included in the design because of the uniform usage of hot water. The technical performance of the system over the first year was outstanding, supplying 32.1% of the McKinnon Building's hot water energy needs. The installation saved 2.86 GJ of oil energy per square metre of collector area. Although the system was not economical, saving $5,975 in the first year as compared to its capital cost of approximately $250,000, it effectively demonstrated that solar energy can displace fuel oil in this application. The demonstraion was a major contribution to the advancement of solar technology. 4 figs., 2 tabs.

25665 (BCME/CT–CE02892) **Low energy housing demonstration project.** British Columbia Ministry of Energy, Mines and Petroleum Resources, Vancouver, BC (Canada). Conservation and Technology Div. [1984]. 43p. (CE–02892). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Low Energy Housing Demonstration Project, which was initated in 1979 under the jointly funded Federal/Provincial Conservation and Renewable Energy Demonstration Agreement (CREDA), attempted to demonstrate and compare the thermal performance of passive solar heating and super-insulation in new single family residential housing. A total of six houses were built under the project in Saanich and Richmond, B.C. At each location, a control house of standard construction, a solar house employing passive solar technology and a Conserver house emphasizing high insulation levels were built. The conserver approach will not generally outperform the solar approach, but factors such as design, climate, solar access, and occupancy lifestyle affect this conclusion. However, the cost of installing insulation and air sealing is more justified than that of passive solar measures. Energy conservation designs should require only basic understanding by the occupant. The project demonstrated the need for furnaces suitable for low-energy houses, and wider acceptance of air to air heat exchangers and triple glazed windows in the marketplace. The houses were then put up for sale and were monitored for energy use after occupancy. Based on a long term predicted fuel consumption for the Richmond houses under standardized interior conditions, the conrol, solar and Conserver houses would consume 117 GJ, 48 GJ and 40 GJ, respectively, which translates into a 59% and 66% energy savings, respectively, over the control house. 4 figs., 8 tabs.

25666 (EEL–90-01242) **Solar thermal technology report.** Enermodal Engineering Ltd., Waterloo, ON (Canada). Nov 1987. 112p. (MICROLOG–90-01242). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report summarizes the status of available products and systems, support services, economics, performance and future prospects for active solar thermal technology. The report emphasises solar technology found in Ontario and, to a lesser extent, the rest of Canada. Solar technology outside of Canada is discussed only if it might reasonably be applied in Ontario. Annual Canadian sales of solar equipment have levelled off at about 99,000 square metres and $14 million, with 40% of the market being in Ontario. The main markets are seasonal pool heating, residential water heating, and commercial/industrial process water and air heating. The market for space heating is almost non-existent. The cost of solar domestic hot water systems has fallen by 60% since 1981 due to the development of lower cost and more easily installed systems. When government subsidy programs end in 1988, the solar industry will face a difficult task in maintaining market share, although there are several niche market and regions of Canada where solar heating may have market penetration. 39 refs., 33 figs., 6 tabs.

25667 (EMR–M91-7/32-1988E) **Renewable energy projects digest 1985-1988: Passive solar.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). Oct 1988. 65p. (MICROLOG–90-01226). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This digest is one of a series of 6 reports which review and update all the current and completed renewable energy (non-bioenergy) projects funded by Energy, Mines and Resources Canada (EMR). This report includes a brief historical and technical account of passive solar technology in Canada and contains over 40 summaries of passive solar projects funded by EMR. Each project entry, in addition to the summary, includes the principal investigator, file numbers, contract start data and completion date, project values, and EMR funding. A key-word index is included.

25668 (FRNC-TH–3569) **Development of an analytic method for the resolution of the heat transfer equations in a porous medium: applications to solar energy.** Gatwaza, E. Poitiers Univ., 86 (France). 1987. 133p. (In French). Order Number DE90770650. Available from NTIS (US Sales Only), PC A07/MF A01.

An analytical method for the resolution of the heat transfer equations in porous medium is presented and applied to gas heating and heat storage. The distribution of the solid and fluid temperatures through the porous medium are determined at every moment and the effects of various parameters are studied flow dynamical characteristics, physical properties of the solid and gas, geometrical parameters of the solid, incident solar flux, etc. The results are in good agreement with those of purely numerical methods.

25669 (LBL–27814) **Failure and degradation modes in selected solar materials: A review.** Lampert, C.M. (ed.). Lawrence Berkeley Lab., CA (USA). May 1989. 143p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. Order Number DE90009075. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This document presents research and development programs involved in solar heating and solar cooling technology. Each report will be cataloged individually. (FSD)

25670 (NBES–CE02897) **Solar domestic water heating, Villa Providence, Shediac, N.B.: Final report.** LeBlanc, A. New Brunswick Energy Secretariat, Fredericton, NB (Canada). Mar 1985. 18p. (CE–02897). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The report describes a project to provide solar water heating for Villa Providence, a nursing home in Shediac, New Brunswick, funded partially by the Conservation and Renewable Energy Demonstration program. Most of the emphasis, to date, in the field of solar heat has been applied to space heating. This had not proven to be efficient in Eastern Canada, as too many collectors are required to be practical and the five most important months of winter are lost, while in the summer months, space heating would not be required. On the other hand, solar heating of domestic hot water could be much more efficient. The system would be in operation during most of the year and would attain an efficiency of almost 90% during the summer months. The solar heating system consisted of 4,271 square feet of solar collectors mounted at a 30 degree angle; a 6,000 gallon hot water storage tank was proposed with an interconnecting system of pipes and electronic controls, double pressure pump and hydropneumatic water tank. Recommendations include selection of a local design company, which would be responsible for the complete project, and budgeting for changes to impractical design concepts. 25 figs.

1410 Solar Collectors and Concentrators

25671 (Juel-Conf–77, pp. 467-478) **Reduction of chromium(VI) when solar selective black chromium is deposited.** Slavkov, D. (Skopje Univ. (Yugoslavia). Tehnolosko-Metalurski Fakultet); Popov, B.; Koneska, Z. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

One of the most common commercial solution for black chrome deposition is ChromOnyx plating solution from the Harshaw Chemical Co., which contains acetic acid as catalyst. But this solution leads to the production of black chrome surfaces with different optical properties as a result of degradation processes of the catalyst. Because of this, the authors have tried another composition of plating bath containing fluorine compounds as catalyst. (Black chrome was electrodeposited from a solution containing 4 M CrO_3 and 0,05 M $BaCO_3$ in presence of fluorine ions.) In order to establish the influence of the constituents as well as that of the catalyst on the process of reduction of chromic acid, measurements of rest potential at open circuit and cyclic voltammetry measurements were made. (orig./MM).

25672 (N–90-14678) **Technology development program for an advanced microsheet glass concentrator.** Richter, S.W.; Lacy, D.E. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1990. 8p. (NASA-TM–102406;E–5158;NAS–1.15:102406;CONF-900449–: ASME international solar energy conference, Miami, FL (USA), 1-4 Apr 1990). Available from NTIS, PC A02/MF A01.

Solar Dynamic Space Power Systems are candidate electrical power generating systems for future NASA missions. One of the key components in a solar dynamic power system is the concentrator which collects the sun's energy and focuses it into a receiver. In 1985, the NASA Lewis Research Center initiated the Advanced Solar Dynamic Concentrator Program with funding from NASA's Office of Aeronautics and Space Technology (OAST). The objectives of the Advanced Concentrator Program is to develop the technology that will lead to lightweight, highly reflective, accurate, scaleable, and long lived (7 to 10 years) space solar dynamic concentrators. The Advanced Concentrator Program encompasses new and innovative concepts, fabrication techniques, materials selection, and simulated space environmental testing. The Advanced Microsheet Glass Concentrator Program, a reflector concept, that is currently being investigated both in-house and under contract is discussed.

25673 (SAND–89-2987C) **Recent progress in photovoltaic concentrator module technology.** Richards, E.H.; Chamberlin, J.L.; Boes, E.C. Sandia National Labs., Albuquerque, NM (USA). [1990]. 11p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-900315–2: Solar '90: 19th American Solar Energy Society annual conference, Austin, TX (USA), 18-20 Mar 1990). Order Number DE90009007. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Significant progress is continuing in the development of photovoltaic (PV) concentrator technology. New record cell and module efficiencies have been achieved, and improvements in cells, cell assemblies, and modules are increasing reliability and decreasing cost. The number of firms actively pursuing PV concentrator module technology has increased substantially in the last three years. Two new concentrator systems were installed last year, and we are likely to see more in the near future. This paper describes the most significant developments of the last two years, including descriptions of PV concentrator module development and reliability activities, advances in concentrator cell technology, the new PV concentrator array installations, a new Concentrator Initiative Program, and results of the latest costing study. 26 refs., 9 figs., 1 tab.

1420 Heat Storage

25674 (FRCEA-TH–243) **Study of a thermal stratification energy storage management optimization.** Capbern, B. CEA Centre d'Etudes Scientifiques et Techniques d'Aquitaine, 33 - Le Barp (France); Bordeaux-1 Univ., 33 (France). 1987. 124p. (In French). Order Number DE90770649. Available from NTIS (US Sales Only), PC A06/MF A01.

Based on the exergy theory, an evaluation method is presented for the prevision of the thermodynamical losses of a thermally stratified energy storage system when subject to irreversible internal decays of its temperature levels. An expression of its perfection degree is given by the storage exergetic efficiency. The exergetic loss criterion shows that the optimal control is attained through injection at several places. The control strategy is then applied to the coupling of this storage system with various thermal machines.

15 GEOTHERMAL ENERGY

1501 Resources and Availability

25675 (DOE/ER/13182–T1, pp. 521-528) **Heat flow and geothermal resource potential of the Atlantic coastal plain.** Costain, J.K. (Virginia Polytechnic Institute and State Univ., Blacksburg (USA)); Speer, J.A. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

Geothermal resources in the Appalachian Mountain system and the Atlantic Coastal Plain can be grouped into four types: (1) heat-producing granitoids in crystalline basement buried beneath the seaward-thickening wedge of Atlantic Coastal Plain sediments of low thermal conductivity; (2) normal geothermal gradient resources, including those areas on the Atlantic Coast Plain over crystalline basement nearly devoid of heat-producing granites; (3) warm water emanating from fault zones (hot springs); and (4) hot-dry-rock in regions of abnormally high geothermal gradient. Resources No. 1 and 2 are the principal subject of this chapter.

1502 Geology and Hydrology of Geothermal Systems

Refer also to citation(s) 27008, 27009, 27010

1509 Geothermal Engineering

25676 Salton Sea Scientific Drilling Program. Sass, J.H. *Earthquakes and Volcanoes (USA)*, 20(4): 147-151 (1988).

The Salton Sea Scientific Drilling Program (SSSDP) was the first large-scale drilling project undertaken by the U.S. Continental Scientific Drilling Program. The objectives of the SSSDP were (1) to drill a deep well into the Salton Sea Geothermal Field in the Imperial Valley of California, (2) to retrieve a high percentage of core and cuttings along the entire depth of the well, (3) to obtain a comprehensive suite of geophysical logs, (4) to conduct flow tests at two depths (and to take fluid samples therefrom), and (5) to carry out several downhole experiments. These activities enabled the U.S. Geological Survey and cooperating agencies to study the physical and chemical processes involved in an active hydrothermal system driven by a molten-rock heat source. The SSSDP exceeded its target depth of 10,000 feet, and a comprehensive set of cuttings, cores, and downhole logs was obtained. Two flow tests at different depths were successfully completed. Hydrologic connection between the different producing horizons, however, made the data from the deeper test difficult to interpret. Temperature logging by the Geological Survey and Sandia National Laboratories to establish the equilibrium profile continued until August of 1987. The SSSDP provides a model for scientific cooperation among government agencies, universities, and private industry.

1510 Direct Energy Utilization

25677 (FRNC-TH-3565) **Optimal control of geothermal heating networks.** Jarrige, P.A. Ecole Nationale Superieure des Mines, 75 - Paris (France). 1987. 102p. (In French). Order Number DE90770648. Available from NTIS (US Sales Only), PC A06/MF A01.

A model for the evaluation and the optimization of a geothermal heating network operation is presented, with the final aim of developing a control software for the geothermal network in Fontainebleau (France). The network is an one-heating station type. A network description language is defined and a reduction algorithm for the non-linear systems is presented and applied to the reduced minimal parametric representation. Simulation results are presented and discussed.

1520 Geothermal Data and Theory

25678 (LBL-28485) **A casting and imaging technique for determining void geometry and relative permeability behavior of a single fracture specimen.** Cox, B.L.; Pruess, K.; Persoff, P. Lawrence Berkeley Lab., CA (USA). Jan 1990. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy; U.S. DOE Energy Research; U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900115-2: 15. workshop on geothermal reservoir engineering, Stanford, CA (USA), 23-25 Jan 1990). Order Number DE90009192. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A casting technique has been developed for making translucent replicas of the void space of natural rock fractures. Attenuation of light shined through the cast combined with digital image analysis provides a pointwise definition of fracture apertures. The technique has been applied to a fracture specimen from Dixie Valley, Nevada, and the measured void space geometry has been used to develop theoretical predictions of two-phase relative permeability. A strong anisotropy in relative permeabilities has been found, which is caused by highly anisotropic spatial correlations among fracture apertures. 16 refs., 6 figs.

16 TIDAL AND WAVE POWER

1607 Tidal Power Plants

25679 (TPC-90-00527) **Tidal Power Corporation annual report 1986-1987.** Tidal Power Corp., Halifax, NS (Canada). [1990]. 11p. (MICROLOG-90-00527). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN.

This annual report of the Corporation presents a description of activities during a year in which sharply lower oil prices during the first few months of the year produced many uncertainties, leading the Corporation to concentrate its efforts on the problems of retiming and fish mortality, both of which must be solved prior to large-scale tidal power development in Fundy Bay, Nova Scotia. Retiming is the process of storing energy at the time of production and releasing it when required by the customer, by either the use of the storage capacity of a large hydro system such as that of Hydro Quebec, or by the use of compressed air storage (CAES). Because of the uncertainties of dealing with Hydro Quebec, a preliminary examination of the geological and other technical aspects of CAES was begun, to be completed in 1987. Fish mortality in the Bay of Fundy is a very important question, due to the presence at both potential sites of feeding fish stocks. The environmental impacts on the United States of the development of the Minas Basin site would have to be addressed. Technology exchange with the Severn Barrage Tidal Power Project in Britain is also continuing. A financial statement is included.

17 WIND ENERGY

1701 Resources and Availability (Climatology)

Refer also to citation(s) 25680, 25686, 25687

1704 Economic, Industrial, and Business Aspects

25680 (ENEL-440.040/29) **Wind power penetration study: ENEL (Italy) contribution.** Botta, G.; Invernizzi, A.; Rivoiro, A.; Panichelli, S.; Salvaderi, L. Ente Nazionale per l'Energia Elettrica, Milan (Italy). Mar 1989. 77p. Order Number DE90764277. Available from NTIS (US Sales Only), PC A05/MF A01.

This wind power penetration study was conducted to evaluate the extent to which wind power can technically and economically be fitted into the ENEL (Italian Electricity Board) productions system, provide background information for the Utility and national energy politics deliberations, and give wind turbine manufacturers guidance for market analysis purposes. The evaluation was done in three steps. First, wind credits were assessed, i.e., capacity credits (corresponding to the conventional generating capacity that in the presence of a wind source can be deferred to obtain a system having the same static reliability) and energy credits (corresponding to the fuel savings in presence of wind generation). Secondly, the interaction of wind power with the system control requirements was analyzed in order to detect whether any penalty might arise due to the intermittance of the wind source and to the fluctuation in wind-turbine output. Thirdly, an extended economic evaluation was performed in order to assess the profitability of investments in wind turbines.

1706 Wind Energy Engineering

Refer also to citation(s) 26086

25681 (DOE/BP/63406–2) **Regional Wind Energy Assessment progress report, June 1985–May 1986.** Wittrup, R.J.; Wade, J.E. Oregon State Univ., Corvallis, OR (USA). Dept. of Mechanical Engineering. Jun 1987. 57p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract BI79-86BP63406. (BPA–87-25). Order Number DE90009381. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report provides an annual summary of the wind statistics at 14 sites in the BPA wind data network collected over the 12 month period from June 1985–May 1986. These data were gathered as part of the BPA's Regional Wind Energy Assessment Program (Wind REAP) that has been ongoing since 1981. Wind data were collected at 5 sites in Oregon, 4 sites in Washington, 1 site in Idaho, 2 sites in Montana, and 2 sites in Nevada. Wind data from the remaining BPA sites will continue to be collected in order to build a long-term data base. Eight of the sites have a database over four years and size sites have over 6 years of data. A long-term data base is essential to understanding the interannual variations of wind. Also, sites with shorter periods of record could be compared to the sites with longer periods of record. The following analysis of the 1985–1986 data consists of two chapters (2.0 and 3.0). Chapter 2.0 is a climatological analysis of the mean monthly wind speeds at selected sites in the Northwest. Deviations of the mean wind speeds from the climatological averages are discussed on a seasonal basis. Chapter 3.0 includes site descriptions and wind characteristics for each of the 14 sites in the BPA service area. 4 refs., 18 figs., 16 tabs.

25682 (DOE/BP/63406–5) **Regional Wind Energy Assessment progress report, June 1986–May 1987: Final report.** Wade, J.E.; Walker, S.; Kenagy, S.Y. Oregon State Univ., Corvallis, OR (USA). Dept. of Mechanical Engineering. Jan 1988. 61p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract BI79-86BP63406. (BPA–88-27). Order Number DE90009379. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report is a summary of wind statistics collected for the period June 1986 through May 1987. The data were gathered at 14 locations throughout the Pacific Northwest. Data are being collected as part of Bonneville Power Administration's Regional Wind Energy Assessment Program (Wind REAP) that has been continuing since 1981. The main objectives in this report are to: summarize data collected during the past year; document the status of each site including any equipment problems and quality assurance; discuss the relationship of this year's winds to those of previous years in the context of the climate experienced in the Pacific Northwest; present analysis of wind characteristics at each site that will provide potential developers with necessary information to assess the quality and quantity of the wind resource; and evaluate the current cost feasibility of wind energy in the Pacific Northwest. 6 refs., 22 tabs., 25 figs.

25683 (ENEA-RT-FARE–89-03) **AERODIN wind turbine design code validation (ENEA, Italian Commission for Alternative Energy Sources).** Arsuffi, G.; Attanasi, S. ENEA, Casaccia (Italy). Dipt. Fonti Alternative e Risparmio Energetico. Oct 1989. 25p. (In Italian). (RT/FARE–89-3). Order Number DE90764319. Available from NTIS (US Sales Only), PC A03/MF A01.

This paper verifies the AERODIN computer code, developed by ENEA (Italian Commission for Alternative Energy Sources) for the aerodynamic analysis of horizontal axis wind turbine rotors. The mathematical model is based on the application of the propulsion theory for propellers combined with the element theory for blades. The numerical results obtained by AERODIN are compared with the experimental ones available in literature. There is good agreement between the numerical and experimental data obtained through wind tunnel performance test on 1.6 and 0.8 m diameter rotors in steady and turbulent air flows.

25684 (KNMI-TR–119) **Spectra and gradients of stormy winds at Cabauw, Netherlands, up to 200 meters.** Meijer, R.W.M. Koninklijk Nederlands Meteorologisch Inst., De Bilt (Netherlands). 1989. 176p. (In Dutch). Available from Koninklijk Nederlands Meteorologisch Instituut, P.O. Box 201, 3730 AE De Bilt, Netherlands.

Observations of atmospheric turbulence have been collected in 1986 by the Royal Netherlands Meteorological Institute (KNMI) at the Cabauw 213 m mast in stormy weather ($U > 8$ m/s). Measurements of wind speed and direction at six levels (10, 20, 40, 80, 140 and 200 m) were sampled at 2 Hz. The analysis is presented of fifteen selected 30-minute runs in similarity form, both dimensionless wind speed gradients and horizontal wind spectra. 58 refs., 4 apps.

25685 (MANECO–CE02971) **Wind energy for remote living.** . MANECON Partnership, Management and Economic Consultants, Edmonton, AB (Canada). May 1983. 38p. (CE–02971). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Canada/NWT Conservation and Renewable Energy Demonstration Agreement program provided a grant of $5,100.00 in October 1981 to Roland and Anne Brandt to assist with the demonstration of the use of wind energy for remote domestic living. The Brandts have installed a small wind power turbine and generation system and operate the system at their residence at Prelude Lake, 40 km NE of Yellowknife, N.W.T. The system consists of a 3 kw wind generator, 30 m mast, 53.6 kWh battery storage, and simple electrical controls. The energy is used to provide domestic lighting and operate other small occasional electric loads in the residence. The project has successfully demonstrated that wind energy fan provide a contribution to the energy needs of a remote residence, and that the technology, obligations and constraints created by its use can be intergrated into the family lifestyle. A large portion of the economic benefits of this system over a diesel electric generation source can be attributed to the availability of an energy storage medium. The addition of a wind generator to a diesel generator system equipped with adequate battery storage, to substitute for the diesel unit, provides much smaller cost savings than those created by batching the diesel energy production into brief periods, storing the energy, and consuming the energy over an extended time. 5 figs., 3 tabs.

25686 (TNO-HMT–88-145-Vol.1) **Handbook wind turbine energy production.** Verheij, F.J.; Van de Snoek, L. (eds.). Hoofdgroep Maatschappelijke Technologie TNO, Apeldoorn (Netherlands). Jul 1989. 133p. (In Dutch). Available from Hoofdgroep Maatschappelijke Technologie TNO, P.O. Box 342, 7300 AA Apeldoorn, Netherlands.

This handbook is the result of a research project on methods to estimate wind turbine energy production in the Netherlands. Three methods with various degrees of complexity and accuracy are presented. By means of these methods the energy production of any arbitrary wind turbine at an arbitrary location in the Netherlands can be calculated based on the wind turbine characteristics (hub height, rotor diameter, power curve) and local wind climate data. The local wind climate is derived from climatological wind data, corrections for terrain rougness and individual obstacles surrounding the chosen location. Method 1 describes the local wind climate as the annual average wind speed being simply obtained from maps and nomograms. For method 2 information is required about the terrain and obstacles around the wind turbine site, where upon the local wind climate is calculated as a so-called Weibull-distribution of hourly average wind speeds. Method 3 requires more detailed data of the surrounding terrain and obstacles in all wind directions. Moreover, statistical data from representative meteorological stations are applied. Method 3 can also be used to estimate wind farm energy production. Comparison with the results of previous wind turbine demonstration projects has shown that the methods presented can estimate the annual wind energy production with an accuracy which is well within the limits of climatological feasibility. The handbook consists of two volumes. For each volume a separate abstract has been prepared. Volume 2 holds the appendices which have to be used for the different calculation methods. 48 figs., 39 refs., 21 tabs.

25687 (TNO-HMT–88-145-Vol.2) **Handbook wind turbine energy production.** Verheij, F.J.; Van de Snoek, L. (eds.). Hoofdgroep Maatschappelijke Technologie TNO, Apeldoorn (Netherlands). Jul 1989. 112p. (In Dutch). Available from Hoofdgroep Maatschappelijke Technologie TNO, P.O. Box 342, 7300 AH Apeldoorn, Netherlands.

The handbook consists of two volumes. For each volume a separate abstract has been prepared. In volume 1 three methods to calculate energy yields of wind turbines are described. Examples of calculations are given. Volume 2 holds the appendices which have to be consulted in the different stages of the calculations. Data are presented on meteorological stations in the Netherlands, topographic coordinates, wind velocities, roughness of and obstacles in different areas including the wind turbines (wake interactions), wind directions, stability corrections, Weibull wind frequencies, the energy yield factor as a proportional quantity, power characteristics of wind turbines and finally the annual energy yield according to method 1.

25688 (VPE–89-05639) **High penetration wind power-diesel coupling: Final report.** Saulnier, B.; Ried, R. V.P.E. Technologie et Affaires Internationales, Varennes, PQ (Canada). Nov 1987. 38p. (MICROLOG–89-05639). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report is about the present status of the design and development of a high wind power, no storage wind/diesel power plant and, of the control and regulation system of this plant. The chosen wind turbine is a 50 kW capacity, 11.7 in. diameter vertical axis Darrieus rotor. The Diesel generator is composed of a Ford Diesel motor and a synchronous Oram generator of 30 kW capacity. The simulated demand represents the demand of a remote village during 1 day; it was represented by a resistor bench of 50 kW, automatically controlled. The dissipative load was identical and controlled by thyristors with a response time of 0.016 seconds. The programmable micro-processor based controller is described. The experimental system has not yet been assembled. The overspeed gear-box and other parts of the Diesel generator have had to be redesigned. A command strategy which depends on wind conditions and the principles of the regulation system are described. The specifications of a data collection programn to be undertaken in Kujjuag are outlined. The experimental plant will not be operational before the end of November 1987. The appendices to the report contain plans and specification of equipment. 20 figs., 8 tabs.

20 FOSSIL-FUELED POWER PLANTS

25689 (OH/RD–90-00569) **Ontario Hydro Research Division annual report 1988.** Ontario Hydro Research Div., Toronto, ON (Canada). 1988. 54p. (MICROLOG–90-00569). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

This annual report presents information on the activities of the Ontario Hydro Research Division. The report summarizes the Division's strategy, and the research being conducted in the areas of process and materials chemistry, chemical analysis, biology and environmental science; durability and endurance testing for hydraulic, thermal and nuclear stations, and the development of the revolutionary water-to-cement ratio concept for mix proportioning of concrete; support for the bulk power system and the municipal distribution systems, as well as comprehensive studies of new techniques in electric power distribution; provision of testing services and technical investigation for the nuclear and transmission systems; metallurgy mainly in support of the nuclear area; and operations research. A list of publications and presentations is also included. 3 figs.

25690 (PB–90-857491/XAB) **Fossil-fuel power plants: Computer systems for power plant control, maintenance, and operation. October 1976-December 1989 (A Bibliography from the COMPENDEX data base). Report for October 1976-December 1989.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 110p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning fossil-fuel power plant computer systems. Minicomputer and microcomputer systems used for monitoring, process control, performance calculations, alarming, and administrative applications are discussed. Topics emphasize power plant control, maintenance and operation. (Contains 240 citations fully indexed and including a title list.)

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Refer also to citation(s) 25379, 25380, 25381, 25738, 26024, 26026, 26379

25691 (DOE/CE/15453–T2) **Particle densitometer based on the acoustical resonance measurement: Second quarterly progress report.** Vetter, A.A. Humbug Mountain Research Labs., Duarte, CA (USA). 2 Apr 1990. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-89CE15453. (HMRL-R–73-2). Order Number DE90008960. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Work continued on development of a particle densitometer based on the Acoustical Resonance Measurement to monitor pneumatically conveyed particle mass loading. During this quarter, work progressed on mock-up of a coal transport piping at a pulverized coal-fired utility power station. 6 refs.

25692 (EPRI-CS–6048, pp. 1.25-1.37) **Cycling fossil steam plants: An EPRI perspective.** Weinstein, R. (Gilbert Commonwealth, Inc., Redding, PA (USA)); Poe, G. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

As load growth in the electric utility industry remains uncertain, cycling of power plants will continue to be necessary to balance out excess capacity. Cycling problems are numerous, and are usually interrelated. A coordinated approach is therefore essential to fully comprehend the net effect from the component to total system level. Many of the EPRI-developed analytical tools have proven very effective in analyzing different cycling scenarios which otherwise might require extensive field testing. The EPRI studies on bypass systems and corrosion product transport can provide important guidance to the industry in optimizing load-up times and in reducing corrosion during shutdowns. The cycling conversion guidelines that are now being developed will provide technical and economic strategies generically applicable to various modes of cycling, and for different plant sizes and equipment designs. EPRI has arranged for an interrelated series of projects that will provide both in-depth, site-specific information as well as general industry guidelines. This consolidation of current utility cycling experience and development of other modification techniques can offer utilities a number of options that can be considered with a step-by-step approach to implementing them. Areas that will be emphasized in future EPRI R&D include design guidelines and specifications for high turndown boilers, environmental control equipment turndown, oxygen reduction techniques for on-off cycling, and on-line demonstrations of the startup advisor and the compact analyzer.

25693 (EPRI-CS–6048, pp. 1.3-1.22) **Trends in the electric power industry.** Armor, A.F. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The cycling fossil plant will be the dominant power producer in the next 10-15 years. To permit these plants to operate at traditional availability levels will not be easy, particularly since most of them will be at least 20 years old. Opportunities for upgrading these cycling units exist now and include improved controls, on-line diagnostic monitors and much improved materials for thick-walled components. Utilities should take advantage of these new developments before the adverse impacts of plant cycling begin to appear. Utilities in the 1990s will be primarily concerned with increased productivity, resulting in low-cost electric power. With increased competition in the industry, possibly stimulated by deregulation activities, the availability and efficiency of our older, cycling units will

be issues of the greatest importance. This cycling conference is therefore both timely and technically significant. Over the next few days we will hear the state-of-the-art as described by utilities, vendors, consultants and EPRI. The next step will be the most important since the technology must be applied to operating fossil units within the next few years. So the challenge to us all is clear. We need to concentrate on technology transfer and on how well we do this may depend the future viability of each individual utility.

25694 (EPRI-CS–6048, pp. 2.19-2.33) **Operating benefits of plant modifications.** Fancher, R.B. (Decision Focus Incorporated, Los Altos, CA (USA)); Jabbour, S.J. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Fluctuating and uncertain electricity demand combined with aging and larger power plants is increasing the need for cycling capacity. Cycling is expensive. Empirical evidence shows that up to one third of the operating costs of cycling plants results from fluctuating loads. More importantly, utilities are beginning to discover that fuel costs are only a small fraction of the total cycling costs, which include increased maintenance, life consumption, and reduced availability. Utilities have started modifying older noncycling power plants to improve the cycling capability of their systems. Plant modifications are costly. The added operating flexibility, however, saves fuel and operating and maintenance costs. Many of the operating savings of plant modifications have gone unidentified in conventional analysis methods for two main reasons. First, some cycling costs cannot be easily measured; thus some savings are unknown. Second, they are perceived as insignificant and are typically ignored. After a recent study provided compelling evidence about the magnitude of these savings, the Electric Power Research Institute asked Decision Focus to develop a computer model to measure typically overlooked savings. Decision Focus developed the model, called DYNAMICS, and used it in two studies for Pacific Gas and Electric Company and Duke Power Company. DYNAMICS is a structured and modular simulation model that focuses on pseudo real-time operation constraints and requirements. It measured the savings that result from plant modifications and modernization of control systems. DYNAMICS, as a modular model, allows an analyst to perform multiple runs on a personal computer and evaluate different modifications options.

25695 (EPRI-CS–6048, pp. 2.37-2.48) **Fossil plant cycling planning perspective.** Pavlou, M. (Public Service Electric and Gas Co., Newark, NJ (USA)); Solowski, S.J. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Public Service Electric & Gas Company (PSE&G) has employed a multitude of methodologies to identify the potential need for fossil plant cycling. These methodologies range from simplistic to computationally complex. Although many utility people are well acquainted with these techniques it is useful to discuss them here to provide others with an approach to identifying the potential need for fossil plant cycling. The paper then discussed characterizing the need for cycling, factors to consider in evaluations, and identifying potential solutions.

25696 (EPRI-CS–6048, pp. 2.51-2.60) **Planning for low load and cycling operating on Eddystone Nos. 1 & 2 supercritical units.** Lloyd, H.M. (Philadelphia Electric Company, PA (USA)); Clelland, P.J.; Gille, J.A. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

As Philadelphia Electric Company and PJM Interconnection increase their nuclear generating capability, they are placing additional demands on their coal-fired units to handle the load swings between the daytime peak load and the nighttime minimum generation. In PECo's case, this means a significant amount of cycling must take place on their remaining coal-fired units, Eddystone Nos. 1 & 2 and Cromby No. 1. PECo has established a Study Team of representatives from all the departments which could contribute to solving the problem of cycling these units. Their objective was to define a set of goals and associated action items which would improve the flexibility of the unit(s) with respect to generation and economy while maintaining safe and reliable operation. At Eddystone Station, the coal was to provide capability of unit operation at a lower minimum load, improve rate of change capability, reduce auxiliary power consumption and determine feasibility of unit operation on a 4 1/2 on - 2 1/2 day off cycle. At Cromby Station, the goal was to provide capability of unit operation at lower minimum load, improve rate of change capability and improve unit on-off cycling ability. The discussion here only addresses the Eddystone units. Since these units are complex, a description of them has been provided. The set of goals defined by the Study Team is described.

25697 (EPRI-CS–6048, pp. 3.103-3.112) **Extended life cyclic operation of turbine generators at Potomac River Units 3, 4, & 5.** Hui, D.Y. (Potomac Electric Power Company, Washington, DC (USA)). Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

PEPCO investigated extended life cyclic operation affects and modification requirements for the turbine-generator of three identical units designed for base-load operation at Potomac River Units 3, 4, and 5. These units were placed in-service in the 1950's and have reached their design life. For the past few years, the operation of these units has been load following and may require two-shift operation in the distant future. An assessment of the existing condition of the equipment and ability of the turbine-generators to operate for an additional life cycle under cyclic operation was performed. This assessment included the rotary and stationary components of the turbine-generators, auxiliary equipment, valves, turbine supervisory instrumentation and control system. The operating and maintenance requirements for extended life cyclic operation were also reviewed. The primary objective of the extended life cyclic operation investigation was to identify and anticipate replacement to the equipment prior to failure in order to prevent extensive forced outages. As a result of this investigation, many of the components were identified for repair and/or replacement in the PEPCO Ten-Year Plan.

25698 (EPRI-CS–6048, pp. 3.29-3.54) **Small turbine bypass and feedwater prewarming.** Hilleman, D.D. (Florida Power and Light Company, Miami (USA)); Millares, M.R. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Two shift cycling of Florida Power and Light plants designed for base load operation has proven detrimental to the boiler, turbine, and feedwater systems. To minimize this damage and its impact on the availability and reliability of the plants, a quality improvement team has recommended the trial implementation of a small turbine bypass system combined with a feedwater prewarming system. The objective of this design modification is to limit the thermal transients and the early failures due to thermal stress. This paper discusses the benefits of a combined small turbine bypass and feedwater prewarming system. Channel head cracking in high pressure feedwater heaters has been studied in depth by FP&L and the results were presented at the November 1985 EPRI Cycling Workshop. Since the small turbine bypass would be available to supply steam to prewarm the feedwater heaters during startups, it was decided to combine the two projects. The turbine bypass/feedwater prewarming system is scheduled for completion in the Fall of 1987. A comprehensive set of monitoring tests will be conducted before

and after implementation to verify the combined system's effectiveness in accomplishing the following goals: (a) Matching steam to turbine first stage metal temperature within the allowable range, (b) Limiting thermal stress levels in the HP feedwater heaters and other HP feedwater equipment, and (c) Providing sufficient steam flow to cool the boiler circuits during startup.

25699 (EPRI-CS–6048, pp. 3.3-3.26) **Deoxygenation in a cycling fossil plant.** Hook, T.A. (NWT Corporation, San Jose, CA (USA)); Pearl, W.L.; Henry, C.; Scheibel, J. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

In a previous EPRI study (Phase I of RP1184-9) at the Port Everglades plant of Florida Power and Light, it was demonstrated that minimizing shutdown oxygen levels at a cycling plant could reduce corrosion product transport to the boilers. A continuation of the program was performed in the spring of 1987 to demonstrate a method to minimize the oxygen levels of a cycling fossil plant. The deoxygenation system utilized an activated-carbon impregnated fiber overlay on a powered resin precoat to catalyze the reaction of hydrazine and oxygen. A series of tests conducted at the Tradinghouse Creek Unit 1 of the TU Electric Company (TUE) quantified the improvement in oxygen control attainable and the effect on corrosion product transport during cyclic operation. The study also demonstrated the application of a data acquisition system for prompt data assessment, control of chemical additions, identification of problems, and development of responsive corrective actions.

25700 (EPRI-CS–6048, pp. 3.57-3.83) **Recent developments in the application of partial-arc turbines to cyclic service.** Silvestri, G.J. Jr. (Westinghouse Electric Corporation, Orlando, FL (USA)); Martin, H.F. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Because of their ability to enhance steam-metal temperature matching when combined with sliding throttle pressure operation, partial-arc admission turbines require lower capacity (lower cost) bypass systems. The flexibility of the partial-arc design was demonstrated during the EPRI funded test series conducted on Collins 5, Commonwealth Edison Co. Operational experience on a 350 MW unit 35% bypass system is also discussed along with the bypass design philosophy that mitigates H.P. exhaust temperature excursions. In addition, the comparative performance of different types of operation (constant vs sliding pressure and full vs partial-arc admission) is discussed. Moreover, the utilization of no-bore rotors improves cyclic duty operation and turbine heat rate. Three rotors utilizing this feature are currently in various stages of design, manufactured or erection. Finally, candidate plant modifications for improved cyclic operation are identified and specific operating recommendations are listed.

25701 (EPRI-CS–6048, pp. 3.87-3.99) **Oxygen control for cycling operation benefits of improved venting–field experience.** Spencer, E. (Graham Manufacturing Co., Inc., Batavia, NY (USA)); Athey, R.E. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This paper describes the causes of high dissolved oxygen in surface condenser condensate under cycling operating conditions and discusses remedies for both existing and new systems. Power plant systems requiring large quantities of makeup water (saturated with oxygen) for cogeneration and district heating purposes impose special dissolved oxygen problems. Several field installations demonstrating these problems are covered, along with some potential solutions.

25702 (EPRI-CS–6048, pp. 4.21-4.35) **Cyclic operation of fossil-fueled combustion engineering steam generators.** Chase, G.M. (Combustion Engineering, Inc., Windsor, CT (USA)); Siddall, W.F. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A variety of boiler components may be adversely affected by cyclic operation. The life expectancy of the heavy-walled pressure parts can be adversely affected by the complex effects of thermally-induced fatigue loadings and creep. Terminal tubes can suffer from fatigue due to the effects of thermal expansion resulting from changes in steam temperatures over the operating regime. Superheater and reheater tubing may be subjected to higher than originally anticipated operating temperatures, particularly with variable throttle pressure operation, but also when operating at low loads with elevated steam temperatures. The firing system must be capable of providing stable combustion at high turndown without the use of high-priced support fuel, and the control system should incorporate features which reduce the burdens on unit operators while providing protection from unsafe or component-damaging conditions. In general, all boilers can be cycled; the real issues that must be addressed are the effect on component life, speed of startup and shutdown, what can be done to ensure reliability.

25703 (EPRI-CS–6048, pp. 4.3-4.18) **Two-shift optimization of a 500 MW coal fired boiler.** Sharrock, M. (Central Electricity Generating Board, Southampton (England)); Lawn, C.J. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Although considerable experience has already been acquired by the CEGB in two-shifting 500 NW oil-fired units, only a few coal-fired ones have so far been required to operate in this manner. This paper describes measures to improve the possible rate of loading one such boiler. The principal problems originally encountered in the loading operation were: 1. Water logging of the platens while the units was off-load led to unacceptably high metal temperatures in the platen superheater during start-up. 2. High temperatures were experienced in the secondary platen superheater and primary platen and outlet headers due principally to non-uniformity in the heat pick-up across the width of the boiler. Some equipment modifications were undertaken to ameliorate these problems. The orifices in the final drain lines were redesigned to allow greater steam flow, and the primary platen outlet boxes were replaced with an up-rated design. Tests were then undertaken to indicate the optimum operational procedures. The relative merits of various oil burner and coal mill combinations, and the desirable limitation on mill loading, were established in terms of the distribution of steam temperatures. These investigations showed that it is possible to achieve a hot start, from first fans in service to synchronization, in under 65 minutes.

25704 (EPRI-CS–6048, pp. 4.39-4.55) **Load cycling effect on electrostatic precipitator performance.** Lane, W.R. (Bechtel Eastern Power Company, Gaithersburg, MD (USA)). Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Boiler load cycling can have a profound effect on operation and performance of electrostatic precipitators. Low load swings affect ash properties, gas flow rates, extent of ash dropout, performance of flue gas conditioning equipment (if installed), and corrosion potential; all of which affect performance and particulate emissions. Oil firing during low load operations of a coal-fired unit can also greatly affect precipitator performance. This paper discusses findings of a cycling performance study of a coal-fired plant. The

operating parameters which affect performance are discussed. Observations and data from cycling operations are presented. Some plants have observed higher particulate emissions during low load cycling while others have observed decreased emissions. Some have had to limit the rate of load increase to prevent emission opacity excursions while others have not. Reasons for cycling affecting various plants in different ways are discussed. A list of considerations when contemplating cycling operation is presented.

25705 (EPRI-CS–6048, pp. 4.59-4.64) **Low cycle fatigue - large centrifugal fans.** Rosenquist, W.A. (Sargent and Lundy, Chicago, IL (USA)). Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The results of investigations and studies involving fan wheel failures and cracking have identified and substantiated that large centrifugal fans can be subjected to low cycle fatigue failure modes. Operating, maintenance, and engineering personnel of fossil-fired units utilizing large centrifugal draft fans should be aware of the causes and potential remedies for low cycle fatigue-induced cracking and failures. This paper identifies the fan wheel characteristics that cause a fan to be more susceptible to low cycle fatigue. The paper also presents suggested programs to monitor and identify the occurrence of low cycle fatigue. Unfortunately, once low cycle fatigue-initiated cracking in critical areas of the fan wheel occurs, very few long-term solutions are currently available except replacing the fan wheel. Suggested interim courses of action are provided along with recommendations regarding long-term mitigation of the effects of low cycle fatigue on replacement fan wheels.

25706 (EPRI-CS–6048, pp. 4.67-4.82) **PG&E experience in cycling conversion of gas fired supercritical power plants.** Laszlo, J. (Pacific Gas and Electric Company, San Francisco, CA (USA)); Chan, B.K. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

PG&E has recently completed construction work on converting the Moss Landing Power Plant Units 6 and 7 to very low load operating capability. As originally installed for base load service over twenty years ago, these supercritical gas and oil fired units were capable of limited cycling operation in the 240 NW to 750 MW range. The increased availability of lower cost off peak power from alternative sources (hydro, nuclear, geothermal) has made it economically imperative to reduce the minimum load on these units, since turning them off during nights and weekends (two-shift operation) is not practical. Of the many possible methods which were considered, B&W's startup/bypass system utilizing the existing flashtank was selected. The original control system was replaced by Westinghouse's DCS. The resulting modified power plant is now capable of automatic operation from 59 MW to full load and a minimum load under manual control as low as 30 MW has been demonstrated. The first unit modified, Unit 7, has successfully operated in the low load region when required by the System Dispatcher, for the past 18 months. Unit 6 has been in operation for six months. The paper describes design, construction and initial operating experience and presents summary cost information.

25707 (EPRI-CS–6048, pp. 5.17-5.56) **Boiler cycling considerations - The EPRI improved coal-fired power plant program.** Palkes, M. (Combustion Engineering, Inc., Windsor, CT (USA)); Touchton, G.; Haneda, H.; Salem, A. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

EPRI initiated a program to develop high efficiency, cycling, coal-fired power plants for the 1990's. The program includes materials and heat rate developments, most of which are applicable not only to the new but also to the existing generation of power plants. The plant design considers the maximum steam conditions for cycling power plants 4,500 psi/1,100/1,100/1,100F. Because the technological solutions are dependent on the plant size, two different plant sizes, 700 MW and 350 MW, were selected for the analysis. For the boiler these solutions include the use of a spiral-wound tube waterwall configuration for the smaller size unit and a vertical waterwall configuration with rifled tubing for the larger one. This paper summarizes the overall boiler design requirements of the EPRI study including design considerations for cyclic mode of operation, describes steam temperature control options and preliminary designs of the 700 MW and 350 MW boilers, and then briefly addresses dynamic simulation techniques and actual operating experience of once-through supercritical boilers designed for cyclic duty in Japan. Steam turbine bypass system, as well as the current state of the study, is also discussed.

25708 (EPRI-CS–6048, pp. 5.111-5.119) **Effective out-of-service storage procedures: An update.** Padgett, C.M. Jr. (South Carolina Electric and Gas, Columbia (USA)); Pearrow, J.J.; Higgins, T.E. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Previous work on boiler lay-up procedures established the efficacy of an out-of-service storage program based on hydroquinone/amine chemistry. Further work at SCE&G's Plant Hagood, as well as other utilities, has refined the procedures and practices that produce successful programs. Since May, 1983, SCE&G personnel have been successfully upgrading both chemical and mechanical aspects of their lay-up procedures. A hydroquinone-based chemical program replaced hydrazine/morpholine and lowered the corrosion rate in the boiler from 35 to 0.3 mils/year. Copper corrosion of the stage heaters during startup also decreased with this new, environmentally safe program. Mechanical improvements included a circulating pump to reach all areas of the boiler (including the superheater) a positive pressure system to prevent oxygen ingress, and dry lay-up of the turbine and condenser. Laboratory and plant data collected during each step of the upgrading are reported. Chemical reactions, coupon evaluation, periodic inspections, and final conclusions are also included.

25709 (EPRI-CS–6048, pp. 5.3-5.14) **Feasibility study of retrofitting a startup steam bypass system to San Diego Gas & Electric's South Bay Unit 2.** Otahal, J.A. (San Diego Gas and Electric Company, Chula Vista, CA (USA)). Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The startup benefits of steam bypass systems are well documented in the literature. South Bay Unit 2, having been converted from base load operation to daily cycling service, seemed to be a good candidate for a steam bypass retrofit. In 1986 a study was initiated to quantify the generally recognized advantages of a steam bypass system, and determine if it made economic sense to install such a system on South Bay Unit 2. This paper describes the engineering study that was conducted to establish the technical and economic feasibility of installing a small (16%) startup steam bypass system on South Bay Unit 2. The study establishes the identifiable cost savings, project cost, and advisability of implementing this bypass system. Two alternate bypass schemes were considered with baseline capital cost estimates ranging from $450K to $600K. Study findings are that it would not be cost effective to implement a bypass system at this time, nor in the foreseeable future.

25710 (EPRI-CS–6048, pp. 5.59-5.107) **Cyclic operation conversion gas fired 175 MW power plants Houston Lighting & Power.** Netherland, B.W. (Houston Lighting and Power, TX (USA)); Weiher, E.R. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct

1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A study to improve the two shift capability and reduce the startup time of five gas fired units was performed by Bechtel Western Power Corporation for Houston Lighting & Power in late 1985. Each of the nominal 175 MW units are approximately 30 years old and has recently experienced an increase in the number of starts per year. Life assessment studies for each unit had been completed by Houston Lighting & Power independent of and prior to the cycling study. Potential plant modifications were screened on technical merit with benefit/cost analysis performed as required for the preferred modifications. These economic evaluations were based on operating the units under a two shift mode unit until the year 2015. Implementation of the modifications was initiated in early 1986 except that the scope of work was based on operation until approximately the year 2000. The major modifications being incorporated in the units are variable pressure operation, turbine bypasses, conversion to steam seals (two units), deaerator pegging, preboiler water treatment, water induction protection upgrades, and upgraded control systems.

25711 (EPRI-CS–6048, pp. 6.3-6.18) **Optimizing ramping operations and demonstrating equipment suitability for cycling a drum-type unit.** del Cerro Tocino, J. (Termicas del Besos, S.A., Barcelona (Spain)); Fitzgerald, F.D. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Foix Power Plant is situated about 50 km south of Barcelona, which is a major center of electrical power consumption. The plant is located near the Mediterranean Sea, allowing the use of seawater for condenser cooling water. A cycling test program of this fossil-fired natural circulation unit is described. The test results relevant to feedwater quality and boiler life expenditure are analyzed and discussed. Modifications to the equipment, control system, and operating procedures are recommended. A method of evaluating header life expenditure using data from the plant data logger is introduced.

25712 (EPRI-CS–6048, pp. 6.41-6.48) **Hudson Unit No. 2 improving cycling ability through operating procedures.** Broderick, M.J. (Public Service Electric and Gas Company, Jersey City, NJ (USA)). Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

With the recent inclusion of 1,540 MW of nuclear capacity from the Hope Creek and Salem Generating Stations into the PSE&G system, it is no longer necessary to base load the 620 MW Hudson No. 2 Unit. Since nuclear fuel costs are lower than fossil fuel costs, it is more economical to reduce Hudson No. 2 Unit's load in off-peak hours and let the nuclear plants supply most of the power. As demand increases, Hudson No. 2 is brought up on load. To avoid weekend shutdowns and substantial economic penalties due to a high minimum load during week nights, cycling down to 150 MW during off-peak hours became the operational goal for Hudson 2. However, this goal was not accomplished overnight. There was a general reluctance to run below 300 MW because of past unit instability at lower loads. It was necessary to make some changes to equipment on the unit in order to achieve sustained operation at 150 MW. The paper describes the modifications to critical pieces of equipment which made it possible to decrease Hudson No. 2 Unit's minimum load from 300 MW to 150 MW.

25713 (EPRI-CS–6048, pp. 6.51-6.68) **Assessing the importance of boiler stored energy on power plant control.** Kieffer, J.C. (Univ. of Texas, Austin (USA)); Masada, G.Y. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This paper describes the effects of boiler stored energy on the controllability of a gas fired power plant. Although the load dependent changes in stored energy are small, they have a significant impact on the input fuel response during variable pressure load transitions. The net changes are greater for sliding pressure operation than for constant pressure operation. It was found that changes in stored energy are not directly related to changes in throttle pressure during load transitions, however the rate of change of throttle pressure does influence the controllability of other boiler controlled variables. Also a proposed control system delay in throttle pressure set point during variable pressure operation did not significantly delay the charging of the boiler stored energy. Using a 235MW gas fired unit as a prototype plant, values of stored energy are computed, a model for the heat exchangers is described, and simulated plant responses are shown to illustrate the points made above.

25714 (EPRI-CS–6048, pp. 6.71-6.88) **Methodology for steam valve chest assessment.** Cunha, F.J. (Public Service Electric and Gas Company, Newark, NJ (USA)). Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The operational reliability of valve steam chests subject to cyclic loading conditions is of concern both from the point of life prediction as well as life extension in existing fossil stations. This paper deals with the methodology required to estimate the remaining useful life of a typical steam chest configuration for continued and reliable operation. A life prediction analysis is performed by applying principles of fracture mechanics and by evaluating creep crack growth rate of existing flaws. Operational constraints are described to assure that the expected remaining useful life can be achieved.

25715 (EPRI-CS–6048, pp. 6.91-6.107) **Simulated plant cycling response of Oswego Unit 5 using a modular modeling system (MMS).** Kulczycky, T.G. (Niagara Mohawk Power Corporation, Syracuse, NY (USA)); Labbe, D.E.; Franchot, C.J. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This paper describes the MMS simulation model of Oswego Unit 5 and summarizes results of its application in support of a cycling project conducted by Niagara Mohawk Power Corporation and EPRI with technical assistance from Stone & Webster Engineering Corporation. The MMS modeling effort was undertaken to identify operational and control areas that could be improved for cycling operation, as well as to determine the applicability of using MMS to investigate cycling operation. The Babcock & Wilcox version of the MMS program was used in conjunction with the Advanced Continuous Simulation Language (ACSL) for the simulation study. Three areas of operation were analyzed: turbine bypass prior to turbine roll; 2nd valve point (low load); and full load. The levels of effort required to formulate, debug, initialize, validate, and execute the model are defined. Capabilities and limitations of MMS and ACSL are identified.

25716 (EPRI-CS–6048, pp. 7.103-7.117) **A predictive maintenance program for cycling fossil steam/electric generating units.** Coles, J.E. (Louisiana Power and Light Co., New Orleans (USA)). Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The recent addition of large nuclear and coal-fired base load capacity to the Middle South System has imposed new and severe changes in the operating requirements of the older gas/oil fired units. Increased number of shutdowns and start-ups and prolonged

operating at low loads with almost daily cycles from 10% to 50% load levels can accelerate the failure rate of unit components. To minimize the effects of these severe operating conditions, Louisiana Power & Light has initiated the development and implementation of a comprehensive Operations and Maintenance Management program that will identify, describe and prescribe those minimum functions and tasks which are essential to the operations and maintenance of plant equipment. A key element of the Management Program will be the Predictive Maintenance Program that will identify, collect, organize and analyze any and all information that might be used to determine what and when maintenance action is required on a specific item of plant equipment. The philosophy and methodology as well as the elements of the Predictive Maintenance Program are included in this paper. The special Predictive Maintenance Services and Technology that are now being established are described.

25717 (EPRI-CS–6048, pp. 7.25-7.43) **Design and operation of the Ishikawa Coal Power Station (156MW x 2 units) (Upgrading of operational performance).** Suzuki, T. (Electric Power Development Co., Ltd., Tokyo (Japan)); Hamauzu, T. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Ishikawa Coal Power Station (156MW x 2 units) of EPDC is a new imported-coal fired power station. The commercial operation of its No. 1 Unit began in November 1986, and that of the No. 2 Unit in March 1987. The electric power system (Okinawa Electric Power System) for which the power station was constructed is a small capacity, independent system. The Ishikawa Coal Power Station required many high operational performances, such as high load change rate, fringe load changes by governor-free (or speed-governing operation) and automatic frequency control operation, lower minimum continuous load operation, auxiliary load operation and shortened startup time. This was accomplished through the use of a sliding pressure plant, turbine bypass system and advanced control system. This paper describes the design and operation of the Ishikawa Coal Power Station with special emphasis on its upgraded operational performance.

25718 (EPRI-CS–6048, pp. 7.3-7.22) **A utility survey of control and monitoring upgrades for cycling operations.** Fruchtman, I. (Ebasco Plant Services Inc., New York, NY (USA)); Poe, G.G. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Monitoring and control system enhancements for fossil units converted to cycling duty are summarized. Data from an EPRI survey of U.S. utilities with cycling units are presented. Results include monitoring-system upgrades to mitigate the effects of cycling on boiler and turbine stresses, on thermal efficiency, and on vibration monitoring strategies. Industry needs for improved plant monitoring are listed. Cycling constraints are reviewed with special attention given to water chemistry.

25719 (EPRI-CS–6048, pp. 7.47-7.63) **Experiences in statistical analysis of the fossil plant cycling process.** Fritz, R.P. (Florida Power and Light Company, Miami (USA)). Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Lauderdale Plant of Florida Power & Light Company consists of two 160 MW oil and gas fired B & W/Westinghouse steam units and 24 aircraft frame combustion turbines. The steam units were placed into service in 1957 and 1958, and began routine daily cycling in approximately 1975. As part of a Statistical Application of Quality Techniques course, being piloted at FPL and given by Japanese professors, a project was undertaken to develop both structure and techniques of a more in-depth analysis of performance relative to the fossil plant cycle. The project format followed a QI (Quality Improvement) story agenda, the major steps of which, are detailed below: (1) Reason for Improvement: Details of why the topic is being considered for analysis; (2) Current Situation: A grasp and analysis of the facts and details of the concern resulting in the establishment of a goal; (3) Analysis: Derivation and validation of cause; (4) Countermeasures: Selection of a solution and implementation plan deals with cause; (5) Results: Tracing of the effectiveness of the solution implementation; (6) Standardization: Formalizing the process with included improvement steps, such that control of the process is maintained; (7) Future Plan: Analysis of future dealings with the topic including a PDCA (Plan, Do, Check, Act) grasp of the problem analysis flow.

25720 (EPRI-CS–6048, pp. 7.67-7.81) **Cycling conversion of Atlantic Electric's B. L. England Unit 3.** Bhamidipati, V.N. (Atlantic Electric Company, Pleasantville, NJ (USA)); Isabella, J.A.; Padera, B.G. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Faced with uncertain oil prices and varying load requirements, Atlantic Electric decided to convert their 162 MW B. L. England Unit 3 from base load to cycling operation. To achieve this objective, an extensive series of studies and inspections was conducted. As a result, modifications were made to the turbine, boiler, and auxiliary steam system and new systems were added. The new systems include a preboiler cleanup loop whose function is to minimize the effect of oxygen corrosion products on the boiler, a turbine bypass system designed to match steam and turbine metal temperatures to minimize hot restart times, and a mechanical vacuum pump to maintain condenser vacuum during unit shutdown. Additional modifications that will be implemented in late 1988 include the installation of steam atomized burners, flame scanners, and a distributed control system. This paper briefly summarizes the boiler and turbine modifications that were made and details the new systems added to the unit to date.

25721 (EPRI-CS–6048, pp. 7.85-7.99) **Coal fired cycling plant experience.** Jochum, R.G. (Illinois Power Company, Havana (USA)); Munini, D.L.; Murray, J.J. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This paper provides a synopsis of experiences gained from nine years and 1,200 plus cycles of operation on a 450 megawatt pulverized coal fired unit with a 26% capacity factor and an 87% equivalent availability. The unit is owned and operated by Illinois Power Company and is located in Havana, Illinois, approximately 50 miles northwest of Springfield, Illinois. The unit was designed for cycling operation with current technology of the mid-70's and has been in service since 1978. Adequate unit information will be provided to explain the basic design of the unit and the operating characteristics that the unit has experienced. The primary emphasis of this paper is to relate maintenance experiences from start-up through current operations. Particular emphasis is given to the effects cycling operation has had on maintenance. Material is approached from a maintenance function at the plant. The overall purpose of the paper is to share experiences gained to date in hopes that this knowledge may help other users prevent similar problems. In addition, suspected problem areas which are unsolved are mentioned to solicit input from users who have reached solutions to similar problems.

25722 (EPRI-CS–6048, pp. 8.17-8.27) **Generation planning, operations and maintenance, and controls working group.** Bosold, R. (Pennsylvania Electric Company, Homer City (USA)); Solowski, S.J.; Weinstein, R.E. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ

(USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This working group was one of two groups to address controls, operating procedures, and maintenance. Two groups were required because of the level of interest in these topics and the participant's appreciation of their importance to cycling issues. This working group also addressed generation planning. Topics of discussion were: generation planning including planning issues and dispatch philosophy; operations and maintenance; controls; and suggestions for new EPRI projects.

25723 (EPRI-CS–6048, pp. 8.3-8.6) **Diagnostics and monitoring working group.** Anderson, D.D. (Wisconsin Public Service Corp., Rothschild (USA)); Jochum, R.G.; Fruchtman, I. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The increased duty imposed on plant components as a result of cyclic operation creates a need for increased diagnosis and monitoring. The repeated temperature changes throughout the system associated with daily load changes and weekly startup and shutdown operation result in cyclic stresses in many plant components. These stresses in turn result in more frequent component failures. Improved plant and component monitoring techniques can be used to identify where increased maintenance can be expected in order to more effectively schedule plant outages and component inspection and repair. At the same time, improved diagnostic techniques can be used to develop procedures and plant designs which will minimize cyclic stresses and to quantify the economic returns for these design changes. These were the general topics which were discussed in this working group. The group included individuals with a broad spectrum of experience including vendors, architect/engineers, consultants, and utility engineers with both plant and staff responsibilities.

25724 (EPRI-CS–6048, pp. 8.31-8.33) **Plant design changes working group.** Andrews, J. (Alabama Power Co., Birmingham (USA)); Wykoff, R.; Rosenquist, W. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The attendees for this discussion group represented a broad spectrum of power plant experience and thus provided a lengthy and broad array of topics where changes should be made to improve plant cycling capability. The participating members first noted their areas of concern on a separate piece of paper and submitted them to the session co-chairman for organization and further discussions by the entire group. These notes present a summary of the suggested changes in areas of involvement, along with a summary of the discussion of group comments. Topics of discussion were: general cycling impact; preventive maintenance; thermal stress and useful life; unit layups; low load operation; water chemistry; feedwater heaters; bypass systems; and turbine water induction.

25725 (EPRI-CS–6048, pp. 8.9-8.13) **Controls, operating procedures, and maintenance working group.** Bosworth, K.L. (Los Angeles Dept. of Water and Power, Long Beach, CA (USA)); Clelland, P.J.; Dixon, R.R. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This working group was one of two groups to address controls, operating procedures, and maintenance. Two groups were required because of the level of interest in these topics and the participant's appreciation of their importance to cycling issues. Summaries are given on the following: controls; instrumentation; operating procedures including variable pressure operation and steam unit simulators; maintenance including low cycle fatigue and dealing with air in-leakage.

25726 (EPRI-GS–6772) **Variable pressure operation: An assessment.** Kimel, E. (Burns and Roe, Inc., Oradell, NJ (USA)); Kemeny, P.; Bierman, E.; Lagomarsino, J.; Clarke, D. Electric Power Research Inst., Palo Alto, CA (USA); Burns and Roe, Inc., Oradell, NJ (USA). c Mar 1990. 246p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report summarizes the benefits, drawbacks, and technical issues of variable pressure operation (VPO) retrofit. Under VPO, turbine throttle pressure is reduced at low loads. This operating mode offers several significant advantages for units that cycle or operate at low loads for extended periods. Information used in the report was assembled from published sources, from major equipment manufacturers, and from utilities operating units under VPO in the US, Europe and Japan. The report also contains statistics of VPO use in this country and abroad. Design features of new units using VPO in Europe and Japan are presented to identify potential directions for future US designs incorporating VPO.

25727 (ORNL/FTR–3544) **[Survey of three isolated diesel power stations in Guatemala]: Foreign trip report, February 4–20, 1990.** Chronowski, R.A. Oak Ridge National Lab., TN (USA). 15 Mar 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009167. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

I traveled to Guatemala City, Guatemala to participate with a team of specialists to study the operating, administrative, and management efficiency of isolated diesel power plants, operated by Instituto Nacional de Electrificacion (INDE). The study is part of a global initiative managed jointly by the Agency for International Development and the World Bank. The power plants were audited, including INDE's largest isolated diesel station, and two much smaller municipal and privately owned stations. I returned to the USA on February 20, 1990.

25728 (PB–90-121864/XAB) **IHI (Ishikawajima-Harima Heavy Industries) Engineering Review, Vol. 29, No. 3, May 1989. Special issue: New technologies concerning steam generator and electric power generation.** Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan). c 1989. 76p. Available from NTIS, PC A05/MF A01.

Text in Japanese with English abstracts. Portions of this document are not fully legible.

Contents: design of 1000 mw gas fired variable pressure operation supercritical once-through steam generator for Higashi Ohgishima Power Station No. 2 unit of the tokyo electric power co., inc.; technologies for coal gasification combined cycle; development of molten carbonate fuel cell; remaining life assessment of aged thermal power plant; development of combustion diagnostic system of burners; development of new type probe for high- and low-temperature use and approach for monitoring techniques of crack extension at high temperature; construction of Sapporo Bridge (main bridge) for Hokkaido Development Bureau.

25729 (PB–90-142274/XAB) **Advanced gas-turbine steam injection. Topical report, September 1987-February 1989.** Thames, J.M. General Electric Co., Cincinnati, OH (USA). Feb 1989. 111p. Available from NTIS, PC A06/MF A01.

The report describes the methodology used to develop and optimize design concepts for adding advanced steam injection techniques to the GE LM1600 aeroderivative gas turbine. Steam injection conceptual mechanical designs and preliminary performance results are also described. Preliminary applications evaluations revealed significant cogeneration market opportunities for natural gas fired gas turbine systems in the 10-20 MW system size range. The LM1600 falls within this range, producing about 13 MW dry and about 17.5 MW with full steam injection. The addition of steam injection features to the LM1600 significantly increases power output and efficiency, provides an effective means for reducing NOx emissions, offers reduced plant equipment costs by eliminating the need for a steam turbine bottoming cycle, and provides the capability to make rapid on-line adjustments in power-to-steam outputs.

25730 (PB–90-159831/XAB) **Municipal waste combustion assessment: Fossil fuel co-firing. Final report, October 1988-July 1989.** Landrum, V.J.; Barton, R.G. D'Appolonia Consulting Engineers, Inc., Harrisburg, PA (USA). Jul 1989. 62p. Available from NTIS, PC A04/MF A01.

The report identifies refuse derived fuel (RDF) processing operations and various RDF types; describes such fossil fuel co-firing techniques as coal fired spreader stokers, pulverized coal wall fired boilers, pulverized coal tangentially fired boilers, and cyclone fired boilers; and describes the population of coal fired boilers that currently co-fire RDF, have previously co-fired RDF but have ceased to do so, and have been used in RDF co-firing demonstrations. (Fossil fuel co-firing, defined as the combustion of RDF with another fuel (usually coal) in a device designed primarily to burn the other fuel, is generally confined to commercial and utility boilers.) Model plants are developed and good combustion practices are recommended.

25731 **Coal-fueled gas turbine combustor island development.** Roberts, P.B. (Solar Turbines, Inc., San Diego, CA (USA)); LeCren, R.T.; Cowell, L.H.; Nobel, M.L.; Hansan, A.M. 10p. American Society of Mechanical Engineers, New York, NY (USA) (1988). (CONF-880607–: 33. ASME international gas turbine and aeroengine congress and exposition, Amsterdam (Netherlands), 5-8 Jun 1988).

88-GT-84.

Solar Turbines Incorporated, a subsidiary of Caterpillar Inc., is currently developing under DOE sponsorship a coal-fueled version of its industrial Centaur Model H gas turbine for cogeneration applications. A critical sub-system component is the coal-fueled combustor island consisting of a Two-Stage Slagging Combustor (TSSC) with an integrated Particulate Rejection Impact Separator (PRIS). Earlier development of the TSSC consisted of basic feasibility demonstrations and emissions evaluations and has been reported previously together with preliminary system design and assessment data. This paper reports on the continued bench-scale development of the combustor island with the objective of developing a data base suitable for use in scaling-up the design by an order of magnitude to a rating consistent with application to the 3.8 MW Centaur Model H gas turbine. Development activities have included analytical and flow visualization modeling; sorbent injection tests for control of sulfur oxides; and baseline evaluations of a continuous slag removal system. A preliminary engine-size combustor island design is also presented.

25732 **Effect of coal constituets on the liquid-assisted capture of impacting ash particles in direct coal-fired gas turbines.** Nagarajan, R. (West Virginia Univ., Morgantown, WV (USA). Dept. of Mechanical and Aerospace Engineering); Anderson, R.J. 9p. American Society of Mechanical Engineers, New York, NY (USA) (1988). (CONF-880607–: 33. ASME international gas turbine and aeroengine congress and exposition, Amsterdam (Netherlands), 5-8 Jun 1988).

88-GT-192.

With the growing interest in burning pulverized coal directly in gas turbines, the problem of fouling–blockage of hot-gas pathways by thick ash deposits–is receiving increased attention. The inertial deposition rate of supermicron ash, which determines the fouling propensity of the coal via the thickness of the deposit, depends linearly on the sticking fraction of ash material arriving at the cooled surfaces, e.g., turbine blades and guide vanes. The magnitude and temperature-dependence of the sticking coefficient will depend on the inventory, composition and physico-chemical properties of the liquid glue consistent with the prevailing temperature, pressure and trace inorganic elemental compositions. As the deposit evolves in time, it encounters several deposition regimes in the order of increasing surface temperature, each characterized by a different source of liquid glue. The effect of coal-ash constituents on the extent of each of these sticking regimes is investigated theoretically here by means of a model of self-regulated ash deposition.

25733 **Flyash adhesion in simulated coal-fired gas turbine environments.** Ahluwalia, R.K. (Argonne National Lab., IL (USA)); Im, K.H.; Wenglarz, R.A. 8p. American Society of Mechanical Engineers, New York, NY (USA) (1988). (CONF-880607–: 33. ASME international gas turbine and aeroengine congress and exposition, Amsterdam (Netherlands), 5-8 Jun 1988).

88-GT-135.

A rich-quench-lean subscale turbine combustor has been used to expose specimens to the products of combustion from several beneficiated coal-water fuels. An analytical scheme is formulated to extract sticking coefficients from the measured weight gain data, particle size spectrum, and particle density and composition. The inferred sticking coefficients, appropriate for impaction on the pressure surface, range between 0.0003 and 0.11 and are strong functions of the gas and surface temperatures but rather insensitive to the impact angle. The implications of results to coal-fired gas turbine operation are discussed.

25734 **Correlation between sodium sulfate mass transfer and low-temperature hot corrosion.** Ahluwalia, R.K. (Argonne National Lab., IL (USA)); Im, K.H. 8p. American Society of Mechanical Engineers, New York, NY (USA) (1988). (CONF-880607–: 33. ASME international gas turbine and aeroengine congress and exposition, Amsterdam (Netherlands), 5-8 Jun 1988).

88-GT-133.

A mass transfer model is developed that considers diffusive and chemical aspects of sodium sulfate formation and deposition on cooled blades of coal-fired gas turbines. The roles of gas phase condensation of sodium sulfate and multicomponent diffusion across a chemically frozen thin boundary layer are elaborated. A rational procedure is presented for correlating material wastage with laboratory weight gain data obtained by exposing alloy specimens precoated with a thin film of salt to SO_2-SO_3 in an oxygen environment. The sodium sulfate mass transfer model is used in conjunction with the correlation to project blade corrosion and lifetime as a function of gas turbine inlet temperature, blade cooling, and sodium and sulfur contaminant concentration.

25735 **Heat storage with CREDA.** Beal, T. (Fostoria Industries, Fostoria, OH (US)). 53p. New York State Energy Research and Development Authority, Albany, NY (USA) (1987). (CONF-870963–: Electric thermal storage conference and exposition, Binghamton, NY (USA), 22-24 Sep 1987).

The principle of operation of ETS or Electric Thermal Storage is discussed in this book. As can be seen by the diagram presented, heating elements buried deep within the core are energized during off-peak periods or periods of lower cost energy. These elements charge the core to a per-determined level, then during the on-peak periods when the cost of electricity is higher or demand is higher, the heat is extracted from the core. The author discusses how this technology has progressed to the ETS equipment of today; this being the finer control of charging rates and extraction of heat from the core.

2002 Waste Management

Refer also to citation(s) 25269, 25305, 25313, 25380, 25381, 25704, 26594, 26596, 26601

25736 (ANL/CNSV-TM–186, pp. 101-106) **Description of a planned CO_2 recovery project in Wyoming.** Tupper, R.J. (Wyodak Resources Development Corp., Rapid City, SD (USA)); Fuller, T. Argonne National Lab., IL (USA). Jun 1988. (CONF-8703302–: Workshop on recovery and use of waste CO_2 in enhanced oil recovery, Denver, CO (USA), 19-20 Mar 1987). In *Recovery and use of waste CO_2 in enhanced oil recovery. Proceedings.* Order Number DE89002803. Available from NTIS, PC A06/MF A01.

Wyodak Resources Development Corp. (Wyodak) has completed studies to determine the market for and the economics of extracting CO_2 gas from the stack gases of a coal-fired electric generating station located in the Powder River Basin near Osage, Wyoming. The results of these studies indicate that there is a market for CO_2 to be used for enhanced oil recovery. This market is, however, dependent on the price of crude oil, the cost to produce CO_2, and the distance of the CO_2 supply from the oil field. Wyodak is prepared to construct a CO_2 plant if contracts can be obtained for its production. If a plant is constructed it will be one of the first plants to be constructed to extract CO_2 gases from a coal-fired

electric generating station and could provide a vast new economical source of CO_2 to be used for enhanced oil recovery.

25737 (EPRI-GS–6208-Vol.1, pp. 2.1-2.16) **On-line, in situ particle measurements in large scale combustion systems.** Holve, D.J. (INSITEC, San Ramon, CA (USA)); Meyer, P.L.; Muzio, L.J.; Shiomoto, G.H. Electric Power Research Inst., Palo Alto, CA (USA); Radian Corp., Research Triangle Park, NC (USA). Feb 1989. (CONF-880305–Vol.1: 7. symposium on the transfer and utilization of particulate control technology, Nashville, TN (USA), 22-25 Mar 1988). In *Proceedings: Seventh particulate control symposium. Volume 1, Particulate/SO_2 control with electrostatic precipitators.* Order Number DE89008056. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A compact, optical probe (PCSV-P) was developed to provide on-line, in situ particle measurements in large scale combustors. Southern Company Services arranged for a demonstration of the probe at the Watson Power Plant. The PCSV-P made measurements of particle concentration, size, and velocity in the furnace (1,330°C) and at the inlet and outlet of the electrostatic precipitator. A comparison of optical probe velocities with measurements made by pitot tubes showed consistent trends in velocity values as function of position in the duct. Cascade impactor and optical probe results were in good agreement for particle sizes up to 4 - 10 microns. The optical probe measures higher particle concentrations at larger particle sizes. Differences in the large particle results are believed to be due to the way in which large particle information is measured and analyzed by the 2 techniques. Optical probe measurements showed that the greatest variation in the velocity and particle concentration occurred at the ESP exit. While the small particle count rate was steady, the large particle count rates varied by a factor of six. These fluctuations indicate that processes such as rapping periodically releases bursts of larger particulate. The most complex velocity flow field was also measured at the ESP exit.

25738 (EPRI-GS–6738) **Material and cleaning options for cyclic reheat systems: Final report.** Rosenberg, H.S. (Battelle, Columbus, OH (USA)); Koch, G.H.; Krause, H.H.; Brockway, M.C.; Keeth, R.J.; Ireland, P.A. Electric Power Research Inst., Palo Alto, CA (USA); Battelle, Columbus, OH (USA); United Engineers and Constructors, Inc., Denver, CO (USA). Stearns-Roger Div. c Mar 1990. 118p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A cyclic reheat system employing tube-type heat exchangers can be used to transfer heat from the inlet flue gas to the outlet flue gas of a wet flue gas desulfurization (FGD) system. Because of the particularly aggressive environment in the heat extraction zone for plants burning high-sulfur coal, corrosion of the tubes can present a serious problem. An inlet gas heat exchanger (heat extractor) test apparatus was built and installed on a slipstream taken after the precipitator of a high-sulfur coal-fired power plant in order to test various tube materials and cleaning methods. The performance of metal and nonmetallic tubes was evaluated during six separate exposure periods that included two temperatures (175 and 205°F, 79 and 96°C) and two cleaning methods (water washing and steam soot blowing). Water washing was performed at two frequencies (1 min/24 hr and 1 min/4 hr) and, during one period, the tubes were not cleaned at all. Steam soot blowing was performed at a frequency of 15 sec/3 hr. The present report summarizes the results obtained from the last three exposure periods. Alloys selected for testing were of the following types: (1) austenitic, ferritic, and duplex stainless steels, and (2) nickel-base alloys. Teflon, graphite, silicon carbide, and Crystar were also tested. 12 refs., 36 figs., 9 tabs.

25739 (EPRI-GS–6798) **Enhanced liners for attenuating utility by-product liquors: Final report.** Martin, W.J. (Pacific Northwest Lab., Richland, WA (USA)); Dennison, D. Electric Power Research Inst., Palo Alto, CA (USA); Pacific Northwest Lab., Richland, WA (USA). c Mar 1990. 129p. Sponsored by Electric Power Research Institute. DOE Contract AC06-76RL01830. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The enhancement of soil liners for selected inorganic solution species by improving attenuation properties neutralizing reagents was investigated. One soil type (Cole silt loam) and two coal combustion liquors [boiling cleaning waste (acidic) and water treatment system brine (alkaline)] were used in laboratory studies. These studies tested the effectiveness of the use of neutralizing reagents both as a direct solution treatment and as a neutralizing barrier in a waste impoundment. The two kinds of laboratory experiments conducted were batch experiments for assessing the reagent's effectiveness and for selecting some for further study, and column experiments to (1) investigate different reagent application techniques, (2) determine the reagent's effects on permeability, and (3) study the changes in contaminant mobility. The batch studies resulted in the selection of two cost-effective neutralizing agents, hydrated lime [$Ca(OH)_2$] for the acidic waste and alum [$Al_2(SO_4)_3 \cdot 8H_2O$] for the alkaline waste. In the column studies, these reagents were incorporated several ways in amending a soil liner to create neutralizing barriers. The results showed that a layered combination of homogeneous amended soil over unamended soil provided the most applicable and effective barrier with acceptable permeability. Precipitation, adsorption, and bacteriological activity were the major mechanisms involved in changing contaminant mobility and permeability. Several mineralogical changes occurred during contact in both studies, although the most significant was the precipitation of iron hydroxide and aluminum hydroxide, with their subsequent adsorption of trace metals. 13 refs., 26 figs.

25740 **Performance testing of HTHP electrostic precipitator at NYU PFBC facility.** Radhakrishnan, R. (New York Univ., NY (USA). Dept. of Applied Science); Gounder, P.K.; Kavidass, S.; Zakkay, V.; Dellefield, R. 8p. American Society of Mechanical Engineers, New York, NY (USA) (1988). (CONF-880607–: 33. ASME international gas turbine and aeroengine congress and exposition, Amsterdam (Netherlands), 5-8 Jun 1988).
88-GT-131.

The authors discuss an ongoing research program to test three types of high-pressure, high-temperature filters. The main objectives of the testing program are: to establish the performance capability of the filters under high-pressure and high-collection efficiency. Shakedown tests for a duration of about 50 hours was completed during October 1986. Testing of the electrostatic precipitator (ESP) is in progress. The first test with ESP was performed during the middle of November 1986. The operating experience with respect to the test facility, and in particular with the particulate sampling systems, is reported in this paper. Additionally, some test results are also discussed.

2005 Environmental Aspects

Refer also to citation(s) 26575, 26585

25741 (EPS–90-00952) **Environmental codes of practice for steam eletric power generation: Construction phase.** Environmental protection series reports, EPS 1/PG/3. Environment Canada, Ottawa, ON (Canada). Environmental Protection Service. Aug 1989. 75p. (MICROLOG–90-00952). Available from PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A series of documents is being developed for the steam electric power generation (SEPG) industry under the provisions of the Canadian Environmental Protection Act. This industry includes fossil-fueled stations (gas, oil and coal-fired boilers), and nuclear-powered stations (CANDU heavy water reactors). In this document, environmental concerns associated with construction activities at SEPG stations are discussed. Practices are recommended for the protection of terrestrial and aquatic life, for the preservation of archeological and historical resources, for erosion and siltation control, for the control of wastewater discharges and spills for the management of solid wastes, for the control of air pollution and noise, and for environmental auditing, monitoring, and reporting. These practices are intended to mitigate or eliminate adverse environmental effects due to construction or modification of steam electric power stations. The SEPG Codes are being developed by working groups of a federal-provincial-industry task force, and are

intended as environmental standards for governments, industry and the public. 40 refs., 5 figs.

25742 (EPS–90-00953) **Environmental codes of practice for steam electric power generation: Construction phase.** Environmental protection series reports, EPS 1/PG/3. . Environment Canada, Ottawa, ON (Canada). Environmental Protection Service. Aug 1989. 66p. (MICROLOG–90-00953). Available from PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

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25743 (MCR–90-01725) **Electricity conservation and acid rain in Ontario: Final report.** Marbek Resource Consultants Ltd., Ottawa, ON (Canada). Mar 1989. 16p. (MICROLOG–90-01725). Available from PC Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report describes a 2-part analysis of the impact that demand management measures could have on Ontario Hydro's acid gas emissions in the 1990s. Part A develops estimates of the potential for and costs of efficiency improvements and conservation by 2000. These estimates are presented as electricity conservation supply curves. Part B presents an analysis of the cost effectiveness as compared with scrubbers of 3 scenarios for acid gas reductions based on electricity conservation measures. This part of the study estimates the potential for and the costs of electricity conservation and efficiency improvements by 2000, developed on a measure by measure basis, detailing costs and the total potential impact of each measure. The results are presented both as supply curves of electricity conservation (total potential in GWh) and as a composite supply curve of generation capacity (in MW). The study found an energy savings potential of at least 33,000 GWh/year by 2000, relative to the frozen 1987 efficiency forecast, all with measures with economic costs under 5 cents/kWh. Nearly half the identified savings potential is in the commercial and institutional buildings sector and about 1/3 of the potential is in the residential sector. The analysis found that scrubbers appear to be a relatively economical option only when the narrow question of acid gas reduction is considered outside the broader context of power system planning and operation. In the broader context, conservation and efficiency produce a stream of economic benefits that more than offset the higher initial investment as compared with scrubbers. 23 refs., 8 figs., 26 tabs.

25744 (NBE–89-06198) **Environmental impact assessment on the proposal by NB Power to construct a thermal generating station in Belledune, New Brunswick: Summary report.** Environmental impact assessment in New Brunswick. New Brunswick Dept. of the Environment, Fredericton, NB (Canada). [1989]. 35p. (MICROLOG–89-06198). Available from PC New Brunswick Legislative Library, Government Documents Section, 766 King Street, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The New Brunswick Electric Power Commission (NB Power) proposes to construct and operate a thermal generating station at Belledune, along the coastline of the Bay of Chaleur, 2 km to the west of the existing Brunwsick Mining and Smelting smelter, capable of burning coal or oil to meet the expected demand for electrical power. The proposed project consists of an initial 450 MW unit scheduled for completion in 1993 and a second similar unit scheduled for completion in 1998. The units will be capable of producing 480 MW under maximum capacity operating conditions, and are expected to operate for at least 30 y. This summary report intended for the general public, includes a consideration of the environmental consequences associated with the construction and operation of the thermal generating station, the associated freshwater impoundment on the Belledune River, and the modifications to the wharf in Belledune Harbour. It describes the existing environment at Belledune; presents the construction and operation plans for the thermal generating plant; and predicts the socio-economic impacts which would result, should NB Power receive Provincial Cabinet approval to proceed. The report also discusses NB Power generation requirements for the period 1988-2002, the choice of Belledune amoung 3 possible sites for the power plant, and NB Power's sulphur dioxide emission control program for the period 1989-2000.

25745 (NBE–89-06199) **General review statement of an environmental impact assessment of a proposal by N.B. Power to construct and operate a thermal generating station at Belledune, New Brunswick.** New Brunswick Dept. of the Environment, Fredericton, NB (Canada). 24 Aug 1989. 8p. (MICROLOG–89-06199). Available from PC New Brunswick Legislative Library, Government Documents Section, 766 King Street, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A review was conducted by representatives of departments and agencies of the Provincial and Federal governments to evaluate the adequacy of the Environmental Impact Assessment (EIA) in addressing the issues raised by the project of a 450 MW coal-or oil-fired generating station at Belledune, New Brunswick. Though this review concluded that the EIA is generally satifactory a number of outstanding issues remain to be resolve. The EIA lacks depth in its examination of ways to address electrical demand and global environmental concerns. NB Power's policy of pre-building large generating stations and using the export sales of electric power to ensure profitability should be carefully reviewed. The assumptions of the EIA with respect to end use reduction, cogeneration, and non-utility energy production are criticized. Other topics which were not addressed in sufficient detail in the EIA are the dredging of the Belledure harbor, the impact on lobster fishing and its appropriate compensation, the disposal of construction wastes, land ownership, and the predicted unusually high dry depostion of acidic compounds.

25746 (NBE–89-06200) **Guidelines for an environmental impact assessment, N.B. Power-Grand Lake coal fired generating station: First draft.** New Brunswick Dept. of the Environment, Fredericton, NB (Canada). 8 Aug 1990. 30p. (MICROLOG–89-06200). Available from PC New Brunswick Legislative Library, Government Documents Section, 766 King Street, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The purpose of this document is to identify the important environmental issues arising from the proposal by the New Brunswick Electric Power Commission to construct and operate a 150 to 200 MW coal-fired generating station at Grand Lake. Guidelines are given to provide a general framework for conducting an Environmental Impact Assessment (EIA). The conduct of the EIA and the preparation of the report are discussed: consultations with the specialists and with the public, identification of valued environmental components, choice of objective criteria for the determination of the importance of the impacts, time and space boundaries of the study, study strategy, prediction of the environmental effects, commitment to monitoring, prevention, mitigation and compensation,

description of the existing environment and of the project, justifications of the project, and evaluation of alternatives. The valued environmental components are listed: impact of air emissions, soil and vegetation, surface water and aquatic life, human health and property, impacts of the cooling water system (water withdrawal, thermal discharge, and superaturation of the water of the lake with dissolved gases), and impacts of increasing or extending the life of the mining industry in New Brunswick. It is recommended, on completion of the study, that NB Power participate in discussions with the members of the review committee proir to the formal submission of the EIA report. 3 refs.

2006 Economic, Industrial, and Business Aspects

Refer also to citation(s) 25922, 25924, 26601

25747 (CANWEC–CE02833 Report 3.1.7) **Private power development in developing countries: Report 3.1.7.** Hull, C.W. (Bechtel Power Crop. (USA)); Townsend, H.D.; Stromberg, J.C. Canadian National Committee, World Energy Conference, Ottawa, ON (Canada). 1989. (CONF-890901–: 14. world energy conference, Montreal (Canada), 17-22 Sep 1989; CE–02833). In *Energy for tomorrow. Division 3: Energy and the economy: Session 3.1: International aspects of energy economics.* Available from Canadian National Committee World Energy Conference, Suite 305, 130 Albert Street, Ottawa, ON, CAN K1P 5G4. Prices: $125.00 CAN.

Developing countries are beginning to pursue private power options because they need new generation financed by new sources of capital and because they seek to reduce public sector deficits and promote efficiency. The key participants in a private power project are the financial community, project developers, and host governments. The developed world has a clear interest in helping developing countries meet their power needs. Facilitating private power development is one means for meeting these needs. Privatization is a promising means to supply critical power demand, but making the promise a reality will require substained committment by all parties. 19 refs., 3 figs.

25748 (EPRI-CS–6048, pp. 2.3-2.15) **Economic justification of load following modifications using life extensions analysis.** Bergeron, J.J. (Louisiana Power and Light Co., New Orleans (USA)); Leigh, M.L.; Hanner, R.R.; Rasmussen, D.M. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Changes in gas/oil fired generating unit operating requirements on the Middle South Utilities system subjected units to daily load changes and frequent shutdowns and start-ups. This has resulted in higher heat rates, thermal fatigue cracking and failure of several major components. Study was made as to modifications that would enable supercritical and subcritical units to run at 10% minimum load for extended periods of time and cycle on a daily basis from 10% to 50% load levels without abnormal damage. The study demonstrated that converting to variable pressure operation and installation of systems which would reduce severity of thermal cycling of major components would be a cost effective way of insuring reasonable component life expectancies. Recommended modifications were identified, cost estimates prepared, and an economic analysis of the 20 year life cycle costs associated with operation of one subcritical unit in a load following, cycling mode, was developed. Costs were compared to those estimated for the unit if operated under as-is conditions. The differential costs were utilized to determine the present worth of the modifications. The components studied, methodologies utilized, and results of these studies are included in this paper.

25749 (EPRI-CS–6048, pp. 6.21-6.38) **The economics of changes in unit ramp rate: System fuel cost and unit cyclic life.** Koch, J. (Boston Edison Company, MA (USA)); Haynes, C.J. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA). Dec 1988. (CONF-871094–: Conference on fossil plant cycling, Princeton, NJ (USA), 20-22 Oct 1987). In *Proceedings: 1987 conference on fossil plant cycling.* Order Number DE89005223. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A formula has been derived with which the fuel cost effects to a generating system due to changes in an individuals unit's ramp rate can be quantified. The results show that in many cases unit ramp rate can be decreased without incurring a substantial fuel cost penalty to the system. (Such a change would be to the ramp rate for daily load demand, not an emergency response rate in the event of the loss of a large unit on the system.) The effects of decreased ramp rate on the life of high temperature power plant components (such as HP turbine shell and rotor) are then discussed. The conclusion drawn is that the desire to change load as quickly as possible is not necessarily the most cost-effective mode of operation. A sample is provided for three typical plants in cyclic operation which illustrates the analysis.

25750 (PB–90-859331/XAB) **Fossil-fuel power plants and power generation: Economic analysis. January 1983-January 1990 (A Bibliography from the NTIS database). Report for January 1983-January 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 185p. Available from NTISPC N01/MF N01.

Supersedes PB–86-869088.

This bibliography contains citations concerning economic analyses and evaluations of utility and industrial fossil-fuel power generation. A wide variety of factors affecting this type of electric power generation are considered. Specific technologies, experiences, and locations are also considered. (This updated bibliography contains 319 citations, 155 of which are new entries to the previous edition.)

2007 Legislation and Regulations

Refer also to citation(s) 25916, 25917, 25918, 25919

21 NUCLEAR POWER PLANTS

Refer also to citation(s) 25816, 27120, 27121, 27130, 27131, 27136, 27139, 27141, 27142, 27143, 27144, 27145

25751 (NUREG–1350-Vol.2) **Nuclear Regulatory Commission information digest: 1990 edition: Volume 2.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Budget and Analysis. Mar 1990. 102p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A05/MF A01; OSTI; INIS.

The Nuclear Regulatory Commission information digest provides summary information regarding the US Nuclear Regulatory Commission, its regulatory responsibilities, and areas licensed by the commission. This is an annual publication for the general use of the NRC Staff and is available to the public. The digest is divided into two parts: the first presents an overview of the US Nuclear Regulatory Commission and the second provides data on NRC commercial nuclear reactor licensees and commercial nuclear power reactors worldwide.

2101 Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled

Refer also to citation(s) 25531, 25534, 25541, 25785, 25797, 25798, 25806, 25810, 25811, 25812, 25813, 25814, 25815, 25817, 25822

25752 (EPRI-NP–6732) **Electrochemical potential measurements under simulated BWR chemistry conditions.** Lin, C.C. (General Electric Co., San Jose, CA (USA). Nuclear Energy Div.); Smith, F.R. Electric Power Research Inst., Palo Alto, CA (USA); General Electric Co., San Jose, CA (USA). Nuclear Energy Div. c Mar 1990. 111p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Electrochemical potentials of Type 304SS, Type 316SS, Platinum and zircaloy have been measured in a high temperature test loop

under various water chemistry conditions. Several types of reference electrodes were used in this study. Effects of chemical additives were systematically examined and the shift of ECP was found to be relatively small (±50 mV) by the addition of most common chemicals studied. However, the effects of Cu ions on the ECP of stainless steel and other materials are more significant. The effect of H_2O_2 was semi-quantatively determined. The increase of ECP compared with the dissolved O_2 at similar levels, was found to range from ~200 mV to ~500 MV. The effect is attributed to the oxidative radicals produced from the catalytic decomposition of H_2O_2 on the stainless steel surface. The effect of water flow rate was also studied for a Type 304SS sample. Without chemical additives, water flow rate (increased from 1 cm/sec to 80 cm/sec) does not affect the ECP of 304SS. However, the impurity and H_2O_2 effects on ECP are more significant at higher water flow rate. Some potential effects of oxide film characteristics and other factors on electrochemical potentials are also discussed in this report.

25753 (EPRI-NP–6779-M) **Investigation of in-leakage and fuel corrosion in certain BWRs: Final report.** Klepfer, H. (Levy (S.), Inc., Campbell, CA (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Levy (S.), Inc., Campbell, CA (USA). c Mar 1990. 10p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The purpose of this study was to investigate a possible correlation between chemical in-leakage and accelerated fuel cladding corrosion in certain BWR's susceptible to localized corrosion failures. The objective of the investigation was to seek plant operating options that could assist in mitigating against localized corrosion failures. 1 refs.

25754 (EPRI-NP–6783) **Considerations for the consolidation of BWR fuel: Final report.** Lindquist, K.O. (Northeast Technology Corp., Kingston, NY (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Northeast Technology Corp., Kingston, NY (USA). c Mar 1990. 113p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

As a precursor to a possible rod consolidation demonstration program with BWR fuel, this study has reviewed the experience base relative to the consolidation of PWR fuel types. In addition, the quantities and types of spent BWR fuel in storage have been assessed. The mechanical design features of the various BWR fuel assemblies have been evaluated to identify special considerations/ tooling/processes which may be required for the consolidation of BWR fuel. The experience base relative to reconstitution of BWR fuel has been reviewed with the General Electric Company, a supplier of BWR fuel reconstitution services, as it may relate to rod consolidation. Target performance objectives for systems designed to consolidate BWR fuel have been developed. These performance objectives establish targets or goals for fuel processing rates, fuel/ NFBC compaction ratios, limits for personnel exposures and acceptable incremental impacts on normal plant operations which BWR rod consolidation systems would seek to achieve. 21 refs., 16 figs., 24 tabs.

25755 (NUREG/CP–0109, pp. 1-12) **LBB application optimization must be our goal.** Arlotto, G.A. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

The paper addressed Leak-Before-Break (LBB) as a goal for optimization. LBB applications were noted as being currently limited to exclusion of hardware for dynamic effects from a pipe break. The Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards recommended that to encourage a technological pursuit of evidence that could justify potential future LBB applications, an avenue for consideration of further extension of the LBB concept should exist. Future applications could be for containment design, Emergency Core Cooling System (ECCS) design, or equipment qualification.

25756 (NUREG/CP–0109, pp. 13-32) **Results of the Japanese carbon steel pipe fracture program.** Takumi, K. (Nuclear Power Engineering Test Center, Tokyo (Japan)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

The paper summarizes a four-year program conducted for MITI on LBB applicability to carbon steel pipes. They conducted 28 straight pipe fracture experiments, and several elbow and tee cyclic loading to leakage tests. For the STS 42 carbon steel pipe investigated, it was concluded that the pipes reached limit load, hence elastic-plastic fracture analysis methods were not needed. As a final result of the program, it was concluded that the concept of LBB is applicable to carbon steel piping in LWRS. 7 figs., 5 tabs.

25757 (NUREG/CP–0109, pp. 33-42) **Background and status of leak-before-break applications in US nuclear power plants.** Wichman, K.R., Lee, S. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

This paper examines the history of LBB licensing in the United States. It discusses the limitation on LBB in the US, LBB acceptance criteria, status of LBB regulatory development, and the status of LBB applications in the US. The authors note that two-thirds of the Presurrized Water Reactors's (PWRs) have received approval for LBB applications to the primary coolant loop. LBB has not been approved for any Boiling Water Reactor's (BWRs) because of continuing concern over inter granular stress-corrosion cracking (IGSCC), even in TP316 nuclear steels.

25758 (NUREG/CP–0109, pp. 43-60) **Acceptance criteria for structural evaluation of erosion-corrosion thinning in carbon steel piping.** Norris, D. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

The paper presents an acceptance criterion for structural evaluation of erosion-corrosion thinning in carbon steel piping. This criterion is currently being considered for implementation into Section XI of the ASME Boiler and Pressure Vessel Code. This evaluation method was developed as a result of a failure of the Surry Unit 2 reactor feedwater piping, and subsequent NDE evaluations showing wall thinning in several other Pressurized Water Reactor (PWR) feedwater piping systems. 11 refs., 6 figs., 2 tabs.

25759 (NUREG/CP–0109, pp. 61-100) **Leak-before-break in French nuclear power plants.** Fraidy, C., Bhandari, S., Jamet, P. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

The paper discussed on-going LBB programs in France. Practical applications of LBB at the present time are quite limited in French nuclear reactors. Some fracture mechanics studies that are complete involve cracks in gas graphite reactor piping systems, primary and auxiliary line pipes in Pressurized Water Reactor (PWR), steam generator tubes in PWRs, and pipes and main pressure vessels in liquid metal fast breeder reactors. The authors state that, although practical applications are currently limited, the French are determined to define a complete validated methodology.

25760 (NUREG/CP–0109, pp. 101-126) **Crack initiation and experimental determination of J in bending for elbows and pipes in austenitic steel.** Jamet, P., Moulin, D.D., Toubol, F., Lebey, J., Acker, D. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

The paper describes a cooperative French research effort. The experiments were performed on cracked straight pipes and elbows with circumferential cracks. The obtained results showed that for shorter circumferential through-wall cracked pipe and elbows in bending, the failure loads were below those predicted by the net-section-collapse equation, unless the flow stress of the material is lowered.

25761 (NUREG/CP–0109, pp. 127-160) **Evaluation of various circumferential through-wall cracked pipe estimation schemes.** Wilkowski, G.M. (Battelle, Columbus, OH (USA)); Brust, F.W.; Chao, K.S.; Gilles, P. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

The paper compared predicted moments at crack initiation and maximum load for through-wall circumferentially cracked pipe in four-point bending. Five different J-integral estimation scheme analyses were used to compare to 16 pipe experiments involving cracks in carbon steel base metal, stainless steel base metal, carbon steel SAWS, and stainless steel SAWS. The pipe diameters varied from 100 to 914 mm. The results showed that the GE/EPRI method was the most conservative, and the Paris and LBB, NRC methods were the least conservative. The LBB,ENG and LBB, NRC methods (developed in the NRC's Degraded Piping Program) were slightly conservative but were still reasonably accurate.

25762 (NUREG/CP–0109, pp. 161-178) **Experiences in applying leak-before-break to Darlington NGS.** Kozluk, M., Vijay, D.K., Lin, T.C., Misra, A.S., Gilbert, K.R. (Ontario Hydro, Toronto (Canada)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

The paper describes the LBB approach being used and experiences with the application to the Darlington Nuclear Generating Station. Significant material characterization and analysis was undertaken in this effort. The analysis efforts involved development of elastic solutions of the crack driving force for curvilinear through-wall axial cracks on the sides of elbows, as well as cracks in branches or tees by using finite element analysis. Finally it was noted that there was a cost benefit in the LBB analysis of approximately 15:1, reduced man rem, a more rational design, and increased licensability. 3 refs.

25763 (NUREG/CP–0109, pp. 179-210) **Regulatory experience in Canada on leak-before-break.** Jarman, B. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

The paper discusses regulatory experiences in Canada on LBB. The paper also discusses the probability of failures in the large diameter (21-inch) heat transport piping. Several examples of cracked pipes and pipe components are given. It is concluded that they have a concern that leak-before-break may become a rationale for eliminating important and effective measures in the defense in depth concept (i.e., in-service inspection) along with poorly conceived measures such as pipe whip restraints.

25764 (NUREG/CP–0109, pp. 211-230) **Research programs in piping fracture behaviour in Italy.** Milella, P. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

The paper summarized the LBB research efforts in Italy from 1981 to 1987. Some of the results are: (1) the net-section-collapse method seems to under estimate the maximum failure loads of carbon steel pipes while it accurately predicts that of stainless steel pipes, (2) the GE/EPRI method is valid method to predict the crack opening displacement and maximum moment for pipes, (3) the Tada-Paris method seems to overestimate the actual leak area in pipes particularly when at bending moments where plasticity occurs, (4) A106 carbon steel pipe can experience severe toughness loss, probably from dynamic strain aging at 280 C, and (5) leak areas remain well below 10 percent of the pipe cross section with through-wall cracks smaller than 160 degrees and load within the ASME Section III normal operating stress loads. An on-going experimental program to verify pipe fracture under inertial loading was also summarized. This program will continue from 1988 to 1992.

25765 (NUREG/CP–0109, pp. 231-260) **Deformation mode crack opening displacement for circumferentially cracked pipes in bending and tension.** Yoo, S.H., Pan, J. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

This presentation showed the results of an NRC-funded program to evaluate the effects of circumferential crack opening and pipe ovalization at fixed ends, i.e., a circumferential crack at a nozzle weld. Elastic shell analyses were conducted. The elastic analysis showed that the pipe diameter, in the bending plane, always increased even with short cracks The observations of decreasing pipe diameter in the bending plane during pipe fracture experiments is believed to be due to a prebuckling elastic-plastic behavior of the uncracked pipe. This was only observed in pipes with short circumferential cracks where the bending loads approached the buckling loads of the pipe.

25766 (NUREG/CP–0109, pp. 261-276) **Stress intensity factors in axisymmetric circumferential crack in cylinder.** Wu, C.M., Chen, L.S. (Materials Research Lab., Hsinchu (Taiwan)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

In this paper an elastic stress intensity factor solution by shell analysis was compared to finite element analyses for circumferentially surface-cracked pipe in axial tension with different stress distributions through the pipe thickness. The solutions generated were for inside radius (R_i) to pipe thickness (t) ratios of 5 to 20. The magnitude of the error was under 5 percent for flaw depths less than 60 percent of the pipe thickness, and R_i/t of 5 to 20.

25767 (NUREG/CP–0109, pp. 277-288) **Ductile fracture analysis by strain energy density function.** Ting, K., Yu, J.S. (Institute of Nuclear Energy Research (China)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory

Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

This paper presented results on ductile fracture analysis by strain energy density functions. They applied the strain energy density approach to a C(T) specimen used in a past Battelle/NRC finite element round robin. They found that the strain energy density function can be used to predict the stable crack growth in ductile fracture analysis, that the approach is easily extended to three-dimensional geometries, and that only the stress-strain curve is needed in the input.

25768 (NUREG/CP–0109, pp. 289-298) **Ductile fracture experiment on through-wall crack piping.** Tseng, C.G. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

The paper reviewed results of ductile fracture experiments on through-wall cracked pipe. The experiments were conducted on 1.5-inch diameter Schedule 20 TP304 stainless steel pipe. The pipe had a circumferential through-wall fatigue crack in the base metal that was approximately 32 percent of the pipe circumference. The pipe was loaded in four-point bending at room temperature. The J-R curve calculated from this experiment was 60-percent higher than that from the 4-inch pipe experiments conducted at Battelle for EPRI. The initiation load was found to be 97 percent of the maximum load, which is consistent with past small diameter stainless steel pipe tests. 4 refs.

25769 (NUREG/CP–0109, pp. 299-336) **Overview of Chinshan Nuclear Power Station recirculation pipe repair and replacement.** Cheng, S.C. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). In *Leak-Before-Break: Further developments in regulatory policies and supporting research.* Order Number DE90007824. Available from NTIS, PC A15/MF A01 - I.

The paper reviewed the weld overlay repairs and pipe replacements, as well as the problems encountered in the repair and replacement procedure.

25770 (NUREG/CR–3950-Vol.6) **Fuel performance annual report for 1988: Volume 6.** Bailey, W.J. (Pacific Northwest Lab., Richland, WA (USA)); Wu, S. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering and Systems Technology; Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 172p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC06-76RL01830. (PNL–5210-Vol.6). Available from NTIS, PC A08/MF A01 - GPO; OSTI; INIS.

This annual report, the eleventh in a series, provides a brief description of fuel performance during 1988 in commercial nuclear power plants and an indication of trends. Brief summaries of fuel design changes, fuel surveillance programs, fuel operating experience, fuel problems, high-burnup fuel experience, and items of general significance are provided. References to more detailed information and related US Nuclear Regulatory Commission evaluations are included. 414 refs., 13 figs., 32 tabs.

2102 Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled

Refer also to citation(s) 25531, 25541, 25607, 25754, 25755, 25756, 25757, 25758, 25759, 25760, 25761, 25762, 25763, 25764, 25765, 25766, 25767, 25768, 25769, 25770, 25785, 25786, 25798, 25800, 25810, 25812, 25813, 25814, 25815, 25817, 25818, 25819, 25820, 25822, 25823, 26060, 27137, 27140

25771 (CEA-DAS–613) **Fuel behaviour and fission product release under realistic hydrogen conditions comparisons between HEVA 06 test results and Vulcain computations.** Dumas, J.M. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (FR). Dept. d'Analyse de Surete); Lhiaubet, G.; Le Marois, G.; Ducros, G. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. Jul 1989. 10p. (CONF-890546–: ICHMT international seminar on fission product transport processes in reactor accidents, Dubrovnik (Yugoslavia), 22-26 May 1989). Order Number DE90762042. Available from NTIS (US Sales Only), PC A02/MF A01.

HEVA 06 test was designed to simulate the conditions of fission products release from irradiated fuel under hydrogen conditions occurring in a PWR core at low pressure. The test conditions were defined from results provided by the core degradation module of the ESCADRE system (1): VULCAIN. This computer code has been recently used to analyse the early core degradation of a 900 MWe PWR in the AF accident sequence (as defined in WASH - 1400, USNRC - 1975). In this scenario, the core would begin to uncover about 1 day after scram with a system pressure of about 0.4 MPa. The fission product release starts 70 minutes after core dewatering. The F.P. are transferred to the core outlet in an increasingly hydrogen-rich steam atmosphere. The carrier gas is nearly pure hydrogen in the period 100 - 130 minutes after core uncovering. A large release of F.P. is predicted in the upper part of the core when the steam starvation occurs. At that time, two thirds of the cladding have been oxidised on an average. Before each HEVA test a fuel sample with a burnup of 36 GWd/tU is reirradiated in order to observe the release of short-lived fission products. A pre-oxidation was primarely conducted in the HEVA 06 test at a temperature of 1300^{0}C and controlled to reach a 2/3 cladding oxidation state. Then the steam was progressively replaced by hydrogen and a heat-up rate of 1.5^{0}C/s was induced to reach 2100^{0}C. The fuel was maintained at this temperature for half an hour in hydrogen. The volatile F.P. release kinetics were observed by on-line gamma spectrometry. Pre-test calculations of F.P. release kinetics performed with the EMIS module based on the CORSOR models (3) are compared with the test results. Measured releases of cesium and iodine are really lower than those predicted. Axial and radial F.P. distributions in the fuel pellets are available from gamma tomography measurements performed after the test.

25772 (EPRI-NP–6705-M) **Measurement of surface-induced microplasticity in Alloy 600 C-rings: Final report.** Lo, C.F. (Rutgers–the State Univ., Piscataway, NJ (USA). Dept. of Mechanics and Materials Science); Kamide, H.; Mayo, W.E.; Weissmann, S. Electric Power Research Inst., Palo Alto, CA (USA); Rutgers–the State Univ., Piscataway, NJ (USA). Dept. of Mechanics and Materials Science. c Mar 1990. 30p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The level of microplasticity in Alloy 600 specimens used for accelerated SCC tests was measured with the aid of a novel x-ray rocking curve technique developed at Rutgers University. With this tool, it was possible to measure quantitatively the strain level at any point along the circumference of a C-ring. Combined with selective etching, the method was used to obtain a depth profile of the strain. A detailed study of the deformation state in C-rings was performed with a particular emphasis on how material parameters influence localization of the strain. These studies included the role of grain boundary carbides, grain size and mill anneal temperatures. The studies led to the development of a numerical model for calculation of the strain distribution along a C-ring which is superior to that currently in use. An additional result of these studies was a simple indirect method that can be used to determine the amount of grain boundary carbides present in tubes of Alloy 600. The final phase of this project was to measure the strain relaxation kinetics in this alloy. From this work, the activation energy for relaxation and the atomistic process responsible were identified. Based on this work, calculations were performed to indicate the degree of relaxation that can be expected during normal steam generator operation and accelerated SCC testing. These calculations suggest that relaxation may be significant in the temperature range of 280–360°C which is typical for such tests and highlights the fact that during these tests significant changes in the microstructure that

can be detected by x-rays are taking place. These results will provide a more accurate basis for extrapolating tests to actual steam generator corrosion experience. 6 figs., 2 tabs.

25773 (KAERI/RR–762/88) **Study on the thermal-hydraulic characteristics of the nuclear reactor core during accident: An experimental study on natural circulation in a PWR loop system.** Cha, Jong Hee (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Chung, Moon Ki; Jin, Yong Suk. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1989. 79p. (In Korean). Order Number DE90623245. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The buoyancy-driven natural circulation in the reactor coolant system of a PWR is expected to be an essential heat mechanism to remove decay heat from the core during hot shutdown in the unlikely event of loss of forced circulation. The objective of this work is to investigate the effects of diminished primary coolant inventory and the presence of noncondensable gas during single and two-phase natural circulation in a PWR loop model. The test model was composed of two loops with a u-tube heat exchanger in each loop. Through a series of tests, it has been confirmed that the two-phase natural circulation flow rates were greatly dependent on primary coolant inventory as a previous investigators observed. The primary coolant inventory limit to maintain two-phase natural circulation was found to be the amount of the coolant necessary to keep the waterline of the coolant nozzle hole center in this model. The presence of noncondensable gas could impede the single-phase natural circulation, but it did not affect the two-phase natural circulation significantly. (Author).

25774 (KAERI/RR–798/88) **Decontamination and decommissioning technology development of nuclear facilities.** Oh, Won Zin (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Won, Hui Jun; Kim, Hong Pyo; Jung, Chong Hun; Park, Sang Yoon; Shim, Joon Bo; Cho, Cheon Hwey; Choi, Wang Kyu. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Feb 1989. 200p. (In Korean). Order Number DE90623246. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

Removal behaviour of an oxide which is similar in structure and composition to that on internal system of steam generator were investigated in low concentration chemical decontamination process [KAERI process]. In the AP solution (oxidative dissolution step), Cr dissolved fastly from the oxide in early stage and then dissolved very slowly in later stage. Dissolution behaviours of Fe from the oxides in the reductive dissolution process were similar to those of Cr in the oxidative dissolution process. Oxide dissolution behaviour in each process were discussed. In twice cyclic application of the oxidative and the reductive dissolution process(KAERI decontamination process), about 50% of the oxide was removed by chemical dissolution, about 40% by particulate detachment. The rest 10% oxide could be completely removed by ultrasonic decontamination. Corrosion acceptance guideline was established for the decontamination of domestic PWRs' steam generator. In the KAERI decontamination process, general corrosion to an Inconel-600 and 304 stainless steel was about 2.4 and 1.0% of general corrosion limit, respectively. And localized corrosion was not observed. Those results indicated that the KAERI decontamination process assured integrity of KNUs' steam generator. To evaluate the radioactive inventory for the decommissioning of nuclear facilities, general calculation methods of radioactive inventory, calculation and measurement of contact exposure rate, and confirmation of those results were reviewed. Feasibility for application of the above methods was examined by taking examples of radioactive inventory estimation in the Shippingport nuclear reactor vessel. (Author).

25775 (KAERI/RR–800/88) **The development of flow test technology for PWR fuel assemblies.** Chung, Moon Ki (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Cha, Jong Hee; Yang, Sun Kyu; Chung, Chang Hwan; Chun, Se Young; Song, Chul Hha; Chung, Heung Joon; Won, Soon Yeun; Cho, Yeoung Rho; Kim, Bok Deuk. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). May 1989. 289p. (In Korean). Order Number DE90623247. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The objective of this project is to design and construct a high temperature and pressure flow test facility and to develop flow test technology for the evaluation of PWR fuel performance. For the nuclear fuel safety aspect it is of importance to evaluate the thermalhydraulic compatibility and mechanical integrity of a newly designed fuel through the design verification test. The PWR-Hot Test Loop facility is under construction to be used to perform a pressure drop test, a lift force test and a fretting corrosion test of a fullsize PWR fuel assembly at reactor operating conditions. This facility was designed to be used to produce the hydraulic parameters of the existing PWR fuel assemblies(14x14FA, 16x16FA, 17x17FA) and to verify a design of advanced fuel assemblies (KAFA-I and KAFA-II) developed by KAERI. The PWR-Cold Test Loop facility with the 5x5 Rod Bundles in the test section was designed and installed to carry out the flow distribution study by means of Laser Doppler Velocimeter. The LDV techniques have been developed and used to measure the flow velocity and turbulent intensity for evaluating mixing effects of a newly designed spacer grid with and without mixing vanes, cross flow between the fuel assemblies and a turbulent model. (Author).

2103 Power Reactors, Nonbreeding, Graphite Moderated

Refer also to citation(s) 25513, 25804, 25809, 25815, 25821, 25822, 26767

2104 Power Reactors, Nonbreeding, Otherwise Moderated or Unmoderated

Refer also to citation(s) 25776

2105 Power Reactors, Breeding

Refer also to citation(s) 25815, 25822, 26901

25776 **Thermionic fuel element verification program: Summary of results.** Samuelson, S.L. (U. S. Department of Energy, Nuclear Energy Division, San Francisco Operations Office, 1333 Broadway, Oakland, CA (US)); Dahlberg, R.C. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899567.

The Thermionic Fuel Element (TFE) Verification Program began in 1986 to evaluate he performance and lifetime of TFEs in a fast reactor. Test data on fueled emitters are being obtained from the TRIGA and EBR-II test reactors. Insulators and cesium reservoirs are being tested in FFTF and EBR-II. Electricity producing TFEs are operating in TRIGA. Components that meet requirements are being identified. The results obtained in the program are discussed.

2106 Power Reactors, Auxiliary, Mobile, Package, and Transportable

25777 **Dynamic Isotope Power Subsystem (DIPS) ground support.** Keshishian, V. (Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.). pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899435.

The ground support system for the Dynamic Isotope Power Subsystem (DIPS) was evaluated to ensure that the DIPS heat source subsystem reflects all the ground handling requirements imposed from factory to flight. The DIPS general purpose heat source (GPHS) canister, which contains GPHS modules, must be safely handled from the time it shipped from the government facility, where the canister is loaded with the GPHS modules, to its final mating with the space vehicle at the launch pad. The ground support system includes the shipping, receiving, inspecting, storage, and installation of the GPHS canister into the DIPS heat source

units at the launch pad. This paper discusses all the ground support activities and demonstrates that all the requirements can be safely met.

25778 Multi-foil thermal insulation for the dynamic isotope power system. Determan, W.R. (Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.); Emmons, J.; Huffman, F.N.; Dunlay, J.; Wortham, D.; Field, G. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899475.

The Dynamic Isotope Power System (DIPS) utilizes MULTI-FOIL insulation around its heat sources in order to minimize thermal losses, reduce weight, and serve as an emergency cooling system in the event of a power conversion subsystem malfunction. DIPS uses a closed Brayton power conversion cycle to convert the isotope decay heat to electrical power. Temperatures within the heat source assembly are maintained at 760-815°C (1400-1500°F) throughout the system lifetime by the MULTI-FOIL insulation. In the event of a power conversion subsystem stoppage, the temperature within the heat source assembly rises quite rapidly, which could jeopardize the integrity of the isotope containment system within the general purpose heat source. Melting of the MULTI-FOIL insulation provides a passive means of reducing the thermal insulation effectiveness and limiting the heat source temperature rise following a power conversion subsystem malfunction. This paper reviews the DIPS MULTI-FOIL insulation design and the testing being conducted to demonstrate feasibility of the design approach.

25779 An assessment of helium gas behavior in SP-100 class reactors. McGhee, J. (New Mexico Univ., Albuquerque, NM (USA). Dept. of Chemical and Nuclear Engineering); El-Genk, M.; Rothrock, R. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899243.

A theoretical investigation into the behavior of helium gas in the primary heat transport system (PHTS) of the SP-100 space nuclear power system was performed. Results indicate that helium gas dissolved in the primary coolant will most likely diffuse out of solution directly into existing bubbles in the system accumulators/gas separators before reaching a concentration sufficient to drive a nucleation process elsewhere in the loop. Differences in individual loop flow rates of only a few percent were demonstrated to have a significant impact on the relative gas diffusion rates in the lop accumulators. Small bubbles which may escape the gas separators will not expand from temperature and pressure changes as they circulate in the PHTS.

25780 SP-100 reactor design and performance. Deane, N.A. (General Electric Co., San Jose, CA (USA)); Murata, R.E.; Kruger, G.B. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899289.

The SP-100 reactor subsystem design has been developed in more detail since last reported. Several key requirements have influenced the design substantially as the more detailed nuclear, thermal/hydraulic, and structural analyses have been completed for the various mission phases including accident safety performance characteristics. This paper summarizes the status of the design evolution as a result of these evaluations and provides a summary of selected performance characteristics for the design as it stood just prior to the System Design Review in May 1988.

25781 SP-100: A flexible technology for space power from 10s to 100s of KWe. Pluta, P.R. (General Electric Co., San Jose, CA (USA). Astro Space Div.); Smith, M.A.; Matteo, D.N. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899287.

The ambitious space missions of the future require a reliable source of electrical energy that exceeds the limits of current technology. The United States is developing space reactor power system technology to meet the projected civilian and defense needs for the 1990's and beyond. This program, known as SP-100, will remove the restrictions on electrical power generation that have limited space missions and will enable the fuller exploration and utilization of space. This paper describes the flexible system that will provide 10's to 100's of kilowatts of electricity and summarizes key technology development underway.

25782 Distribution and detection of positrons from an orbiting nuclear reactor. Hones, E.W. (Los Alamos National Lab., NM (USA)); Higbie, P.R. *Science (Washington, D.C.) (USA)*, 244(4903): 448-451 (28 Apr 1989).

The Solar Maximum Mission (SMM) Gamma-Ray Spectrometer has on many occasions detected nuclear radiation produced by nuclear reactors carried on Soviet satellites. A unique feature of the observations is the measurement of bursts of 511-kiloelectron volt gamma rays that are thought to signal SMM encounters with positrons emanating from the Soviet satellites. A model of positron generation by an orbiting reactor has been developed that describes the resulting time-dependent distribution of positrons temporarily trapped in the geomagnetic field and estimates the response of the SMM spectrometer to passage through such distributions. The model successfully predicts onset times, durations, and intensities of the 511-kiloelectron volt gamma bursts, as we illustrate in a detailed analysis of one event, and thus confirms that these are due to positrons from the Soviet satellites. Reactor-generated positrons are potentially useful in magnetospheric research. 16 refs., 5 figs.

2107 Regulation and Licensing

Refer also to citation(s) 25607, 25755, 25756, 25757, 25758, 25759, 25760, 25761, 25762, 25763, 25764, 25765, 25766, 25767, 25768, 25769, 25798, 25799, 25800, 25813, 25814, 25817, 25822

25783 (NUREG--0540-Vol.2-No.11) **Title list of documents made publicly available, November 1--30, 1989: Volume 2, No. 11.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Freedom of Information and Publications Services. Mar 1990. 333p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A15/MF A01 - GPO - OSTI.

This monthly publication contains descriptions of the information received and generated by the US Nuclear Regulatory Commission (NRC). This information includes docketed material associated with civilian nuclear power plants and other used of radioactive materials and nondocketed material received and generated by NRC pertinent to its role as a regulatory agency. As used here, docketed does not refer to Court dockets: it refers to the system by which NRC maintains its regulatory records. This series of documents is indexed by a Personal Author Index, a Corporate Source Index, and a Report Number Index. The docketed information contained in the Title List includes the information formerly issued through the Department of Energy publication Power Reactor Docket Information, last published in January 1979.

25784 (NUREG--0750-Vol.30-No.5) **Nuclear Regulatory Commission issuances: Volume 30, No. 5.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Freedom of Information and Publications Services. Nov 1989. 392p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A17/MF A01 - GPO; OSTI; INIS.

This report includes the issuances received during the specified period from the Commission (CLI), the Atomic Safety and Licensing Appeal Boards (ALAB), the Atomic Safety and Licensing Boards (LBP), the Administrative Law Judge (ALJ), the Directors' Decisions (DD), and the Danials of Petitions for Rulemaking (DPRM).

25785 (NUREG--0940-Vol.8-No.4) **Enforcement actions: Significant actions resolved: Quarterly progress report, October--December 1989: Volume 8, No. 4.** Nuclear Regulatory

Commission, Washington, DC (USA). Office of Enforcement. Mar 1990. 301p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A14/MF A01 - GPO; OSTI; INIS.

This compilation summarizes significant enforcement actions that have been resolved during one quarterly period (October–December 1989) and includes copies of letters, Notices, and Orders sent by the Nuclear Regulatory Commission to licensees with respect to these enforcement actions. It is anticipated that the information in this publication will be widely disseminated to managers and employees engaged in activities licensed by the NRC, so that actions can be taken to improve safety by avoiding future violations similar to those described in this publication.

25786 (NUREG–1386) **Technical specifications: Seabrook Station, Unit 1 (Docket No. 50-443): Appendix A to License No. NPF-86.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation. Mar 1990. 410p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A18/MF A01 - GPO; OSTI; INIS.

The Seabrook Station, Unit 1 Technical Specifications were prepared by the US Nuclear Regulatory Commission to set forth the limits, operating conditions, and other requirements applicable to a nuclear reactor facility as set forth in Section 50.36 of 10 CFR Part 50 for the protection of the health and safety of the public.

2108 Economics

Refer also to citation(s) 25812, 25924, 25925

22 NUCLEAR REACTOR TECHNOLOGY

2201 Theory and Calculation

Refer also to citation(s) 25809

2202 Components and Accessories

Refer also to citation(s) 25804, 26060, 26064, 26416, 26417, 27116, 27120, 27121, 27381

25787 (KAERI/RR–751/88) **Study on radiation damage of reactor component materials: Analysis and evaluation of radiation embrittle of SA 508 welds.** Choi, Sun Pil; Hong, Jun Hwa; Nho. Kye Hoe; Han, Dae June; Chi, Se Hwan; Kim, Dae Whan; Lee, Bong Sang; Kim, Sung Soo; Song, Hoon; Oh, Jong Myeong. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Feb 1989. 40p. (In Korean). Order Number DE90623236. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A physically meaningful method for analyzing the Charpy impact test data has been studied and an analytical expression for the absorbed energy has been deduced from the 'standard anelastic solid equation' (C.M. Zener, 'Elasticity and Anelasticity of Metals', University of Chicago Press, Chicago and London, 1948), showing the Debye characteristics. Therefore, it is apparent that the transient in the absorbed energy is due to a thermal activation process between a brittle state and a ductile state of materials, so that the Charpy impact data (the absorbed energy) can be characterized by four quantities such as the upper shelf energy, the lower shelf energy, the activation energy, and the characteristic temperature. The present method has been applied for evaluation of radiation embrittlement of SA 508 welds('Irradiation Nuclear Pressure Vessel Steel Data Base', EPRI NP-2428, Electric Power Research Institute, June 1982). It is observed that SA 508 welds are divided into two groups: the majority has an activation energy of 2.4 E-20 joule and the other has 1.66 E-20 joule and that these values are abruptly changed to 4.2 E-20 joule and 2.4 E-20 joule, respectively, at a fluence of approximately 5 E 18 neutrons/cm^2($E > 1.0$ MeV). And it is also observed that the characteristic temperature of unirradiated SA 508 welds falls within (261$\pm$5)deg K regardless of its activation energy and the change with respect to the fluence is approximately represented by M 3x ln(f/4.34 E 17)$\pm$22 deg K. (Author).

2203 Fuel Elements

Refer also to citation(s) 25775, 25794, 25804, 27120, 27121, 27123, 27124, 27125, 27138

2204 Control Systems

Refer also to citation(s) 25805

25788 (KAERI/RR–728/88) **Multiprocessor development for robot control.** Lee, Jong Min (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Kim, Seung Ho; Hwang, Suk Yeoung; Sohn, Surg Won; Kim, Byung Soo; Kim, Chang Hoi; Lee, Yong Bum; Kim, Woong Ki. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 217p. (In Korean). Order Number DE90623239. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The object of this project is to develop a multiprocessor system which is essential to robot technology. A multiprocessor system interconnecting many single board computer is much faster and flexible than a single processor. The developed multiprocessor will be used to control nuclear mobile robot, so a loosely coupled system is adopted as a robot controller. A total configuration of controller is divided into three main parts in related with its function. It is consisted of supervisory control part, functional control part, remote control part. The designed control system is to be expanded easily for further use with a modular architecture, so the functional independency within sub-systems can be obtained throughout the system structure. Electromagnetic interference affecting to the control system is minimized by using optical fiber as communication media between robot and control system. System performances is enhanced not only by using distributed architecture in hardware, but by adopting real-time, multi-tasking operating system in software. The iRMX86 OS is used and reconfigured for real-time, multi-tasking operation. RS-485 serial communication protocol is used between functional control part and remote control part. Since the developed multiprocessor control system is an essential and fundamental technology for artificial intelligent robot, the result of this project can be applied directly to nuclear mobile robot. (Author).

25789 (KAERI/RR–734/88) **Development of compact nuclear simulator.** Ham, Chang Shik (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Kwon, Kee Choon; Lyu, Sung Phil; Kim, Jung Taek; Jung, Chul Hwan; Lee, Dong Young; Hwang, In Koo; Kim, Young Gil; Kim, Jung Soo; Park, Won Man. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 206p. (In Korean). Order Number DE90623349. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

Compact nuclear simulator is designed to carry out various operational modes as real nuclear power plant: startup, preoperational test, preheating, hot startup, cold shutdown, power control and operational conditions in steady and accident states. It can be used for training of the operators, maintenance personnel, regulatory inspectors, system or component designers, NSSS designers, safety analysis by transient analysis and for making questions for an operator qualifying examination and training of research fellows in the Nuclear Training Center of KAERI. The TMI accident resulted from the defect of the man-machine interface of main control room and of the quality of the operators. No proper action on the malfunction of small part in a system can cause severe accident like TMI-2 accident, so it is very important urgent to upgrade the operators' capability and to train operators for the understanding of dynamic transient phenomena in plant system. So it is necessary to develop CNS which is very efficient to train operators, operation and maintenance supervisors, maintenance personnel and inspectors of regulation committee to understand the dynamic transient phenomena. This report is the final report of KAERI-CNS project which was designed and manufactured in '85.7-'88.12. This CNS was designed and fabricated in conjunction with STUDSVIK, Sweden and installed at KAERI-NTC, and entitled KAERI-CNS. KAERI and STUDSVIK have developed math. modeling software. Many parts of CNS hardware were supplied by local firms.The followings are major parts of this project performed in '85.7-'88.12. 1.Contract

with STUDSVIK for joint design and manufacturing CNS 2.Selection of malfunctions and design and manufacture of console panel 3.Manufacture of interface card and graphic display system 4.Software module development 5.S/W and H/W integration 6.Factory acceptance test and Site acceptance test 7.Running test. (Author).

25790 (ORNL/FTR–3565) **[First international conference on supercomputing in nuclear applications (SNA'90)]: Foreign trip report, March 9–20, 1990.** Knee, H.E. Oak Ridge National Lab., TN (USA). 4 Apr 1990. 22p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90009298. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler was the guest of Japan's Atomic Energy Research Institute who provided funding to cover the traveler's expenses while in Japan. The traveler was an invited speaker at the First International Conference on Supercomputing in Nuclear Applications (SNA'90). The paper presented by the traveler was entitled "The Advanced Controls Program at Oak Ridge National Laboratory," and was well received. Subsequent to the conference, the traveler met with representatives of the Power Reactor and Nuclear Fuel Development Corporation's (PNC's) Frontier Research Group on Artificial Intelligence to discuss mutual research interests. Research areas dealing with operator cognitive modeling, supervisory control, advanced balance of plant control and automation, experimental human performance, control strategy integration, and the operator associate concept were of particular interest to PNC. Other Japanese organizations visited by the traveler included Mitsubishi Electric Corporation's Central Research Laboratory, the Human Factors Research Center (operated by the Central Research Institute of the Electric Power Industry), and the Institute of Human Factors at the Nuclear Power Engineering Test Center. In many areas of the nuclear industry the Japanese seem to be emerging as world leaders. However, it is the traveler's opinion that in the areas of advanced controls and human cognitive modeling, the US (and especially ORNL) has a significant technical lead when compared to similar research efforts in Japan.

2205 Environmental Aspects

Refer also to citation(s) 25741, 25742, 25796, 26766, 26767, 26778, 26782

25791 (NUREG–0837-Vol.9-No.4) **NRC TLD [Nuclear Regulatory Commission thermoluminescent dosimeter] direct radiation monitoring network: Progress report, October–December 1989.** Struckmeyer, R.; McNamara, N. Nuclear Regulatory Commission, King of Prussia, PA (USA). Region I. Mar 1990. 298p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A14/MF A01 - GPO; OSTI; INIS.

This report presents the results of the NRC Direct Radiation Monitoring Network for the fourth quarter of 1989. It provides the ambient radiation levels measured in the vicinity of 75 sites throughout the United States. In addition, it describes the equipment used, monitoring station selection criteria, characterization of the dosimeter response, calibration procedures, statistical methods, intercomparison, and quality assurance program.

25792 (WSRC-RP–89-815) **Reactor operation environmental information document: Volume 1, Geology, seismology and subsurface hydrology.** Haselow, J.S.; Price, V.; Stephenson, D.E.; Bledsoe, H.W.; Looney, B.B. Westinghouse Savannah River Co., Aiken, SC (USA). Dec 1989. 244p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009117. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

The Savannah River Site (SRS) produces nuclear materials, primarily plutonium and tritium, to meet the requirements of the Department of Defense. These products have been formed in nuclear reactors that were built during 1950–1955 at the SRS. K, L, and P reactors are three of five reactors that have been used in the past to produce the nuclear materials. All three of these reactors discontinued operation in 1988. Currently, intense efforts are being extended to prepare these three reactors for restart in a manner that protects human health and the environment. To document that restarting the reactors will have minimal impacts to human health and the environment, a three-volume Reactor Operations Environmental Impact Document has been prepared. The document focuses on the impacts of restarting the K, L, and P reactors on both the SRS and surrounding areas. This volume discusses the geology, seismology, and subsurface hydrology. 195 refs., 101 figs., 16 tabs.

2206 Research, Test, and Experimental Reactors

Refer also to citation(s) 25808

25793 (KAERI/RR–763/88) **Fluid flow test for KMRR fuel assemblies.** Chung, Moon Ki (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Yang, Sun Kyu; Chung, Chang Hwan; Chun, Se Young; Song, Chul Hha; Chung, Heung Joon; Won, Soon Yeun; Cho, Yeoung Rho; Kim, Bok Deuk. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Jan 1989. 104p. (In Korean). Order Number DE90623255. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

The objective of this test program is to obtain the experimental data of pressure drop and subchannel flow distribution for the KMRR (Korea Multipurpose Research Reactor) fuel assembly, and to investigate mechanical integrity of the fuel assembly and flow tube in the test flow condition. The experimental data produced through this study are applicable to the KMRR fuel design and thermal-hydraulic analysis of the reactor. Pressure drop correlations for each types of fuels were developed which can be applicable over Reynolds number of $6x9x10^2 \approx 8.0x10^4$. Local velocity in the subchannels of the fuel assemblies was measured with laser doppler velocimeter system, and the velocitily distribution was also calculated with a computer program developed through this study. The experimental data are used as input for the core thermal margin analysis and safety analysis in steady/accident conditions of the KMRR. (Author).

25794 (KAERI/RR–803/88) **The development and localization of nuclear fuel technology for KMRR.** Kim, Dong Hoon (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Kim, Seung Yun; Lee, Ji Bok; Suk, Ho Chun; Kuk, Il Hyun; Hwang, Woan; Kim, Bong Goo; Park, Joo Hwan; Kim, Young Jin; Kang, Thae Khapp. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). May 1989. 381p. (In Korean). Order Number DE90623256. Available from NTIS (US Sales Only), PC A17/MF A01; OSTI; INIS.

Aim of this research is to design and fabricate the KMRR(Korea Multipurpose Research Reactor) fuel, which will be loaded at October, 1933. This research were divided into three parts: fuel design, fuel fabrication and process criticality analysis. In fuel design, the preliminary product specification and design manual for the fuel rod and assembly of KMRR fuel have been prepared. The subchannel analysis has been performed for the assembly composed of 6-fin and 8-fin fuel elements, respectively and the thermal performance of 8 finned KMRR fuel element has been compared with that of the 6 finned element. In fuel fabrication, studies made on coating of crucible handling of zirconia crucible, prevention of Si loss, plasma coating, pouring condition, distribution of melt, removal of skull in vacuum induction melting and casting. Casting technologies were reviewed in the inductin melting as well as in arc melting in order to improve the recovery and to achieve the proper alloy compositions. The primary U_3Si particle size was examined in conjunction with the cooling rate. The kinetics of peritectoid reaction was followed in conjunction with the primary particle size. Powder size distribution and the degree of oxidation were examined following the hammer mill condition. The minimum particle size for the completion of the peritectoid reaction was determined in powder heat-treatment. Extrusion performance was reviewed varing mixture ratio between Al and U_3Si powder. Mechanical properties are also varied with the mixture ratio between Al and U_3Si powder. Surface quality was examined in terms of extrusion speed. Preliminary experiment was made in plugging for rolling design. GTA welding was performed in order to find the weldability in aluminium. In process criticality analysis group, criticality calculation were made about 5 major fabrication process using AMPX-KENO computation system. (Author).

25795 (PB–90-859521/XAB) **Cold neutrons: Sources and applications. January 1975-January 1990 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1975-January 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 99p. Available from NTISPC N01/MF N01.

Supersedes PB–88-859004.

This bibliography contains citations concerning cold neutron sources from a research reactor, the use of liquid hydrogen or deuterium to enhance the thermal equilibrium, the storage and lifetime of cold neutrons, neutron guides and transport to direct the beam to a test specimen, and specific applications as non-destructive test instrumentation. Test instrumentation includes neutron radiography, microscopy, spectrometry, and diffractometry. Tests are related to structural changes in turbine blades, crystal defects and fatigue studies in metals and weldments, crystal lattice studies in inorganic compounds, determination of inhomogeneities in thin films, and fundamental physics experiments. (This updated bibliography contains 200 citations, 12 of which are new entries to the previous edition.)

2207 Plutonium and Isotope Production Reactors

Refer also to citation(s) 25792, 25801, 25802, 25803, 25811, 25821, 25825, 25826, 25828, 26778

25796 (WSRC-RP–89-1198) **Numerical simulation of groundwater flow and contaminant transport at the K, L, and P areas of the Savannah River Site, Aiken, South Carolina: Final report.** Westinghouse Savannah River Co., Aiken, SC (USA); Camp Dresser and McKee, Inc., Atlanta, GA (USA). Nov 1989. 132p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009250. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The Department of Energy (DOE) is preparing an Environmental Impact Statement (EIS) as part of the process for continuing operation of three reactors at the Savannah River Site (SRS). As required by the National Environmental Policy Act (NEPA), the EIS must address the potential environmental consequences to human health and the environment of this "major federal action." Some of the possible consequences are related to subsurface transport of radionuclides released to seepage basins during normal reactor operation. To assist in the evaluation of the potential subsurface environmental impacts of these releases, Camp Dresser & McKee Inc. (CDM) was contracted in June of 1989 to develop a three-dimensional groundwater flow and contaminant transport model which will simulate the movement of radionuclides at each of the reactor areas after they enter the groundwater system through the seepage basins. This report describes the development, calibration, and simulation results of the groundwater flow and contaminant transport model developed for this task. 10 refs., 63 figs., 11 tabs.

2208 Propulsion Reactors

Refer also to citation(s) 25824

2209 Reactor Safety

Refer also to citation(s) 25555, 25605, 25606, 25607, 25610, 25613, 25755, 25756, 25757, 25758, 25759, 25760, 25761, 25762, 25763, 25764, 25765, 25766, 25767, 25768, 25769, 25770, 25785, 25786, 25791, 25792, 25796, 25829, 26064, 26532, 26541, 26901, 27106, 27108, 27109, 27110, 27111, 27114, 27115, 27116, 27120, 27121, 27122, 27123, 27124, 27125, 27130, 27131, 27136, 27137, 27138, 27139, 27140, 27141, 27142, 27143, 27144, 27145, 27357, 27381

25797 (BMU–1989-225) **German standard problem (GSP) No. 9 'Dynamical behaviour of piping systems with a non-return valve under blowdown conditions'. Comparative assessment report.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Firnhaber, M.; Mueller, W.C. Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Gesellschaft fuer Reaktorsicherheit mbH (GRS), Koeln (Germany, F.R.). Sep 1988. 251p. (In German). Contract BMU SR 279. (GRS-A–1486). Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.). Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

In case of a feedwater pipe rupture in a BWR type reactor, the feedwater non-return valves are to limit the outflow of water from the pressure vessel, and thus the release of radioactivity. Upon closing of the valve, a pressure flush will pass through the piping system and cause considerable loads. The objective of the Standard Problem No. 9 is the investigation of the capability of computer codes, for piping systems. These are used in design and licensing by experts, to predict the behaviour of a large pipe. For the purpose of completeness all relevant loadings are considered: (1) static loads, (2) eigen values, (3) dynamic loads. For the comparison typical variables used are the following: (1) displacements, (2) moments, (3) stresses and strains. The comparison between experiment and calculation shows that the degree of agreement varies as well for the participants, the loadings as the variables selected for comparison. The analysis shows, that the greater part of the calculation differs from the experiment by not more than 10%, but no uniform tendency can be found. Neither the contributions by a single participant nor the total of all calculations for one variable lie completely inside the given 10% boundary. Specific parameters, which are known only approximately have been determined as sources of discrepancies. In the licensing procedure these uncertainties are covered by safety margins. Considering that the calculations are performed 'best-estimate', the static and modal results are adequate. The dynamic results are satisfactory for the first oscillation. (orig./HP).

25798 (BNL-NUREG–43041) **Assessment of candidate accident management strategies.** Lehner, J.R.; Luckas, W.J.; Vandenkieboom, J.J. Brookhaven National Lab., Upton, NY (USA). [1990]. 8p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (CONF-8910222–20: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). Order Number DE90008815. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A set of candidate accident management strategies, whose purpose is to prevent or mitigate in-vessel core damage, were identified from various NRC and industry reports. These strategies have been grouped by the challenges they are intended to meet, and assessed to provide information which may be useful to individual licensees for consideration when they perform their Individual Plant Examinations. Each assessment focused on describing and explaining the strategy, considering its relationship to existing requirements and practices as well as identifying possible associated adverse effects. Two example assessments are presented here. Complete assessments of all the strategies identified are contained in Draft NUREG/CR-5474. 8 refs., 1 figs.

25799 (CONF-890833–1) **Analysis of corrective action data from trial program on programmatic performance indicators.** Mays, G.T.; Poore, W.P. Oak Ridge National Lab., TN (USA). [1989]. 7p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. From 14. biennial conference on reactor operating experience: plant operations - the human element; Charlotte, NC (USA); 6-9 Aug 1989. Order Number DE90008886. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Nuclear Regulatory Commission (NRC) is considering the use of cause codes as performance indicators (PIs) to monitor licensee performance. In conjunction with the cause codes, corrective action codes are also under consideration to describe licensee corrective actions for problems as represented by the cause codes. The set of cause codes and corrective actions employed in a trial program to assess their usefulness included: (1) administrative error – training; (2) design/installation – procedure modification; (3) fabrication error – discipline; (4) random equipment failure – management change; (5) licensed operator error – design modification; and (6) other personal error – equipment replacement/adjustment. These causes were selected to represent a broad range of licensee programs, hence the designation of programmatic PIs, that could be monitored in a systematic manner to identify trends in performance. They should establish a basis and focus for further

investigation of a particular programmatic area if undesirable trends are evidence. 2 figs.

25800 (CONF-9003110–1) **Some ongoing research in the U.S. that relates to nuclear reactor pressure components.** Pugh, C.E. Oak Ridge National Lab., TN (USA). Mar 1990. 22p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. From IAEA international working group on reliability of reactor pressure components; Vienna (Austria); 14-16 Mar 1990. Order Number DE90008569. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The presentation of US research programs at the last IWG-RRPC meeting emphasized several aspects of the work sponsored by the Nuclear Regulatory Commission (NRC). The remarks given this year will focus on work that relates to pressurized water reactor primary pressure vessels. While most of the comments are relative to NRC work, some are included relative to the Electric Power Research Institute (EPRI) and the Department of Energy. Additionally, a forthcoming CSNI workshop on fracture methodology validation will be described. 36 figs.

25801 (DPST–87-412) **Summary of the second series of SRL fuel melt experiments.** Whitkop, P.G. Savannah River Lab., Aiken, SC (USA). 23 Jul 1987. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009126. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The SRL fuel melting experiments described in DPST-86-406 employed melt temperatures of either 700 or 1100°C. In an effort to extend this data base to intermediate temperatures, improve the analytical data and help answer some questions brought out by the first experiments, a second series of experiments were carried out. This second series included U/Al alloy fuel samples along with U_3O_8/Al powder metallurgy fuel samples. Air, argon and steam/argon atmospheres were again used, but melt temperatures of 850 and 1000°C were investigated. These supplementary experiments are summarized in HEDL report #HEDL-7651. 10 refs., 6 figs., 1 tab.

25802 (EED–860302) **[Area metallurgical report L tank inspection].** Vormelker, P.R. Savannah River Lab., Aiken, SC (USA). 3 Nov 1986. 34p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-76SR00001. Order Number DE90009258. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Visual and liquid penetrant inspections of the 105-L reactor tank were performed during the period, July–October, 1986, under Test Authorization 1-2247. A total of 29 linear indications were found visually. They were either red or black in color and ranged from very sharp to broad and more stain-like. The sharper indications were similar in appearance to the visual indications found in the C reactor tank knuckle region which had been confirmed as cracks by ultrasonic and liquid penetrant inspection in 1985. Fourteen of the longest or most crack-like indications were inspected by liquid penetrant methods and none were found to be cracks. The remainder were less than half the calculated allowable flaw size and were not examined further. 16 refs., 4 figs.

25803 (EED–870200) **P-Area reactor tank: Area metallurgical report.** Vessel, E.M. Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab. 26 May 1987. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-76SR00001. Order Number DE90009304. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Visual inspection of approximately 20% of the wall welds of the SRP reactor tanks are performed on a five year frequency per Reactor DPSOL-105-1851B. As part of an enhanced visual inspection program a total of 50% of the tank wall welds were inspected during the 1985 and the 1986 P-Reactor Tank inspections. At that time, it was recommended that 100% of the tank wall welds he inspected during the 1987 visual inspection of P-Tank with the EED improved inspection equipment. No visual indications indicative of cracking were observed in the welds or their associated heat affected zones. Reactor fuel and target positions were vacated per Attachment 1 to allow insertion of the inspection equipment. Twelve telescope positions were examined and video tape recorded. The entire bottom-T weld was not visible from the vacated telescope positions due to the closeness to the wall and the limited tilt angle of the mirror on the telescope. Attachment 3 identifies the welds examined. The tank vertical welds in the area of Nozzle 3 were positively identified. The other tank vertical welds could not be visually identified, but the general areas where they are located were inspected. 9 refs., 3 figs., 3 tabs.

25804 (ENEA-RT-DISP–89-05) **Chernobyl accident analysis: Positive reactivity assessment.** Buccafurni, A.; Landeyro, P.A. ENEA, Rome (Italy). Direzione Sicurezza Nucleare e Protezione Sanitaria. Oct 1989. 96p. (In Italian). (RT/DISP–89-05). Order Number DE90764338. Available from NTIS (US Sales Only), PC A05/MF A01.

Estimates were made of the positive reactivity introduced through the growth of the coolant void fraction in a graphite-water steam-generating reactor, both at the average value of burnup given by the Soviets and at the maximum value. Using Monte Carlo models, various possible axial distributions of burnup , displacer models, conditions in control channels and positions of control rods were considered in calculating the insertion of positive reactivity with the fall of the manual and emergency control rods, i.e. positive scram. The possibility of positive reactivity insertion due to the creation of a mixture of fuel, water and cladding in a number of central fuel channels was examined. This situation corresponds to the explosion of these channels, and is considered, in this paper, as the cause of the second reactivity peak. At the level of the data presented in this study, vaporization of the cooling water in the fuel channels can be considered as the cause of the Chernobyl accident. The accident began in the region of the channels close to the axis of the reactor and spread to its periphery. The positive reactivity due to insertion of the manual and emergency control rods (positive scram) played a marginal role in the development of the accident.

25805 (EPRI-NP–6748) **Control-room operator alertness and performance in nuclear power plants: Final report.** Baker, T.I. (Circadian Technologies, Inc., Boston, MA (USA)); Campbell, S.C.; Linder, K.D.; Moore-Ede, M.C . Environmental Protection Agency, Washington, DC (USA); Circadian Technologies, Inc., Boston, MA (USA). c Feb 1990. 209p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

All industries requiring round-the-clock operation must deal with the potential problem of impaired alertness, especially among those who work night shifts. In the nuclear power industry, maintaining optimal alertness and performance of control room operators at all times of day is critical. Many of the toot causes of reduced alertness are straightforward and can be easily remedied with tangible solutions; this manual both discusses the reasons for the problem and suggests solutions. The manual surveys factors that influence operator alertness and performance, including shift schedules, caffeine and alcohol use, diet and family lifestyle factors, the control room enviornment, staffing and overtime practices, and work task design. Specific recommendations are made in each of these areas. The project team, consisting of experts on managing round-the-clock operations and scientists who study human alertness and performance, prepared this manual using the latest scientific research and direct input from shift supervisors and operators via interviews, on-site observation, and questionnaires distributed to every nuclear power station. The material contained within is relevant to shiftwork managers, shift supervisors, and operators, each of whom plays a vital role in maintaining optimal alertness and performance on the job. 90 refs., 35 figs.

25806 (EPRI-NP–6787) **BWR radiation-field assessment, 1986–1988.** Kincaid, C.B. (General Electric Co., Pleasanton, CA (USA). Vallecitos Nuclear Center); Peterson, J.P. Electric Power Research Inst., Palo Alto, CA (USA); General Electric Co., Pleasanton, CA (USA). Vallecitos Nuclear Center. c Mar 1990. 122p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This interim report describes the results of a program to further the understanding of recirculation system shutdown dose rate buildup and to identify effective measures for reduction of this buildup. Measurement data are presented for 17 BWRs visited between September 1986 and November 1988 and observed trends

relative to plant characteristics which may affect dose rate buildup are discussed. 16 refs., 25 figs., 32 tabs.

25807 (HC–89-8(Annex)) **Guidance on accidents involving radioactivity: Emergency planning in the NHS. Health Service arrangements for dealing with accidents involving radioactivity.** Department of Health, London (UK). [1989]. 49p. (HN(FP)–89-8). Order Number DE90623080. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This annex contains advice to Health Authorities on their response to accidents involving radioactivity. The guidance is in six parts:-(1) planning the response required to nuclear accidents overseas, (2) planning the response required to UK nuclear accidents (a) emergency plans for nuclear installations (b) nuclear powered satellites, (3) the handling of casualties contaminated with radioactive substances, (4) background information for dealing with queries from the public in the event of an accident, (5) the national arrangements for incident involving radioactivity (NAIR), (6) administrative arrangements. (author).

25808 (HEDL-SA–3706) **Uncovering the trends.** DeCelis, D.G. Sr. Westinghouse Hanford Co., Richland, WA (USA). 6 Apr 1987. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76FF02170. (CONF-8704394–1: American Society for Quality Control (ASQC) meeting, Richland, WA (USA), 20 Apr 1987). Order Number DE90009136. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

After an initial period of implementing company wide performance indicators, there remains a significant next step. That step is trending some of the variables which lead to changes in the major performance indicators. This paper describes what practical results may be expected from performing this type of trend work at an operating nuclear facility, and how such a program may be economically implemented. 6 figs.

25809 (Juel–2316) **Physics of the pebble-bed high temperature reactor in massive water ingress accidents.** Scherer, W. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Reaktorentwicklung. Oct 1989. 60p. (In German). Order Number DE90767347. Available from NTIS (US Sales Only), PC A04/MF A01.

A point-kinetics model was developed to describe qualitatively hypothetical water ingress transients in the primary loop of High Temperature Reactors. Neutron kinetics, heat-flow balance and the chemical reaction of graphite corrosion together with their mutual influence are included. The qualitative behaviour of the transients is calculated and discussed for two fictitious examples, namely the long-term water ingress into a medium sized HTR (HTR-500) and the 'startup' of a small HTR after an intensive water flooding of the core. The model developed and the computer code KINKOR are thought to be tools for the general understanding of the water ingress phenomena and should be looked at as basis for more elaborated systems. (orig./HP).

25810 (KFK–4550) **Safety research for LWR type reactors. 1988 annual report.** Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projektgruppe LWR-Sicherheit (PRS). Jul 1989. 260p. (In German). Order Number DE90767413. Available from NTIS (US Sales Only), PC A12/MF A01.

The current R and D activities are to be seen in connection with the LWR risk assessment studies. Two trends are emerging, of which the one concentrates more on BWR-specific problems, and the other on the efficiency or safety-related assessment of accident management activities. This annual report of 1988 reviews the progress of work done by the institutes and departments of the Karlsruhe Nuclear Research Center, (KfK), or on behalf of KfK by external institutions, in the field of safety research. The papers of this report present the state of work at the end of the year 1988. They are written in German, with an abstract in English. (orig./HP).

25811 (NEDC–30837) **Stress corrosion cracking literature review and analysis for the Savannah River Plant.** Gordon, B.M.; Mehta, H.S. General Electric Co., San Jose, CA (USA). Dec 1984. 170p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009245. Available from NTIS, PC A08/MF A01 - OSTI.

Operating reactors at the Savannah River Plant (SRP) have performed successfully for up to 30 years. The reactor structural components consist primarily of a stainless steel vessel, piping, and piping components. The reactor operates at temperatures not exceeding approximately 100°C and the heavy water coolant is characterized by 1 ppm (mg/l) oxygen and about 2 ppm deuterium peroxide. pD is controlled to a level of approximately 5.1 by nitric acid addition to reduce the corrosion of the aluminum clad fuel elements. This study provides a survey of available literature relevant to the cracking behavior found at the SRP. Although most of this literature is derived from laboratory and in-reactor BWR studies, many elements are relevant to SRP conditions since BWR startup environments overlap the SRP moderator in many respects. The literature review and analysis are divided into two sections. The first section provides a review of available water chemistry and materials interaction data and provides an overall assessment of susceptibility to SCC of SRP Type 304 stainless steel components. The second section contains a flaw tolerance and crack growth rate assessment useful in analysis of cracks that may potentially be identified at SRP. 45 refs., 56 figs., 5 tabs.

25812 (NUREG/CP–0105-Vol.1) **Seventeenth water reactor safety information meeting: Proceedings: Volume 1, Luncheon and dinner talks; Equipment qualification of valves; Generic safety issues resolution; Human/system interface and personnel research; Organization and reliability research.** Weiss, A.J. (Brookhaven National Lab., Upton, NY (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1990. 489p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (CONF-8910222–Vol.1: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). Available from NTIS, PC A21/MF A01 - GPO - OSTI.

This report contains papers that were presented at the Seventeenth Water Reactor Safety Information Meeting held at the Holiday Inn Crowne Plaza, Rockville, Maryland, during the week of October 23–25, 1989. The papers are printed in the order of their presentation in each session and describe progress and results of programs in nuclear safety research conducted in this country and abroad. Foreign participation in the meeting included ten different papers presented by researchers from France, Germany, Japan, Norway and the United Kingdom. The titles of the papers and the names of the authors have been updated and may differ from those that appeared in the final program of the meeting. This document, Volume 1, discusses the following: equipment qualification of values; generic safety issues resolution; human/system interface and personnel research; and organization and reliability research. Each report will be cataloged individually.

25813 (NUREG/CP–0105-Vol.2) **Seventeenth water reactor safety information meeting: Proceedings: Volume 2, Accident management; severe accident research; earth sciences; probabilistic risk assessment; seismic and structural engineering.** Weiss, A.J. (Brookhaven National Lab., Upton, NY (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1990. 515p. Sponsored by Nuclear Regulatory Commission. (CONF-8910222–Vol.2: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). Available from NTIS, PC A22/MF A01 - GPO; OSTI; INIS.

This three-volume report contains 84 papers out of the 111 that were presented at the Seventeenth Water Reactor Safety Information Meeting held at the Holiday Inn Crowne Plaza, Rockville, Maryland, during the week of October 23–25, 1989. The papers are printed in the order of their presentation in each session and describe progress and results of programs in nuclear safety research conducted in this country and abroad. Foreign participation in the meeting included ten different papers presented by researchers from France, Germany, Japan, Norway and the United Kingdom. The titles of the papers and the names of the authors have been updated and may differ from those that appeared in the final program of the meeting. Each report will be cataloged individually.

25814 (NUREG/CP–0105-Vol.3) **Seventeenth water reactor safety information meeting: Proceedings: Volume 3, Primary systems integrity; plant performance, testing and analysis;**

piping and NDE [nondestructive examination]; plant aging. Weiss, A.J. (Brookhaven National Lab., Upton, NY (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1990. 529p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (CONF-8910222–Vol.3: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). Available from NTIS, PC A23/MF A01 - GPO; OSTI; INIS.

This three-volume report contains 84 papers out of the 111 that were presented at the Seventeenth Water Reactor Safety Information Meeting held at the Holiday Inn Crowne Plaza, Rockville, Maryland, during the week of October 23–25, 1989. The papers are printed in the order of their presentation in each session and describe progress and results of programs in nuclear safety research conducted in this country and abroad. Foreign participation in the meeting included ten different papers presented by researchers from France, Germany, Japan, Norway and the United Kingdom. The titles of the papers and the names of the authors have been updated and may differ from those that appeared in the final program of the meeting. Each report will be cataloged individually.

25815 (NUREG/CR–2331-Vol.9-No.3) **Safety research programs sponsored by Office of Nuclear Regulatory Research: Progress report, July 1–September 30, 1989: Volume 9, No. 3.** Weiss, A.J. (comp.); Azarm, A.; Baum, J.W.; Diamond, D.J.; Fitzpatrick, R.; Ginsberg, T.; Greene, G.A.; Haber, S.B.; Higgins, J.C.; Khan, T.A. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Feb 1990. 112p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (BNL-NUREG–51454-Vol.9-No.3). Available from NTIS, PC A06/MF A01 - GPO; OSTI; INIS.

This progress report describes current activities and technical progress in the programs at Brookhaven National Laboratory sponsored by the Division of Regulatory Applications, Division of Engineering, Division of Safety Issue Resolution, and Division of Systems Research of the US Nuclear Regulatory Commission, Office of Nuclear Regulatory Research following the reorganization in July 1988. The previous reports have covered the period October 1, 1976 through June 30, 1989. 25 refs., 12 figs., 5 tabs.

25816 (NUREG/CR–5460) **A cause-defense approach to the understanding and analysis of common cause failures.** Paula, H.M. (JBF Associates, Knoxville, TN (USA)); Campbell, D.J.; Parry, G.W.; Mitchell, D.B.; Rasmuson, D.M. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Sandia National Labs., Albuquerque, NM (USA); JBF Associates, Knoxville, TN (USA); NUS Corp., Gaithersburg, MD (USA). Mar 1990. 132p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–89-2368). Available from NTIS, PC A07/MF A01 - GPO - OSTI.

For improved reliability and safety, nuclear power plants are designed with redundant safety systems, many of which also have redundant trains of equipment within the system. However, the very high reliability theoretically achievable through the use of redundancy is often compromised by single events that can individually render redundant components unavailable (common cause failure [CCF] events). As evidenced by the results of probabilistic risk assessments (PRAs) and by historical experience with nuclear power plant operations, CCF events are usually major contributors to the risk posed by nuclear power plant operation. Thus, it is important that PRAs recognize the potential for CCF events and realistically account for CCF contributions to system unavailability and plant risk. Much progress has been made over the years in the area of CCF analysis, including the development of both qualitative analysis methods. Until now, however, CCF methodologies have not explicitly and systematically accounted for the impact of plant-specific defenses, such as design features and operational and maintenance policies, in place to reduce the likelihood of failure occurrences at nuclear power plants. Recognizing the importance of this issue, the NRC has funded a research effort that has focused on developing the cause-defense methodology for CCF analysis and prevention. This report presents the results of this research. Specifically, this report discusses the development of (1) procedures for identifying the potential for CCF events at individual nuclear power plants and (2) cause-defense matrices for analysis of CCF events. Also, new concepts and more precise definitions are introduced to enhance CCF terminology and interpretation of historical event data. 35 refs., 8 figs., 32 tabs.

25817 (NUREG/CR–5474) **Assessment of candidate accident management strategies.** Luckas, W.J. (Brookhaven National Lab., Upton, NY (USA)); Vandenkieboom, J.J.; Lehner, J.R. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Brookhaven National Lab., Upton, NY (USA). Mar 1990. 45p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (BNL-NUREG–52221). Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

A set of candidate accident management strategies, whose purpose is to prevent or mitigate in-vessel core damage, were identified from various Nuclear Regulatory Commission (NRC) and industry reports. These strategies have been grouped in this report by the challenges they are intended to meet, and assessed to provide information which may be useful to individual licensees for consideration when they perform their Individual Plant Examinations. Each assessment focused on describing and explaining the strategy, considering its relationship to existing requirements and practices as well as identifying possible associated adverse effects. 10 refs.

25818 (NUREG/CR–5513-Vol.1) **Accident management information needs: Volume 1, Methodology development and application to a pressurized water reactor (PWR) with a large, dry containment.** Hanson, D.J. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Ward, L.W.; Nelson, W.R.; Meyer, O.R. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; EG and G Idaho, Inc., Idaho Falls, ID (USA). Apr 1990. 67p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (EGG–2592-Vol.1). Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

In support of the US Nuclear Regulatory Commission (NRC) Accident Management Research Program, a methodology has been developed for identifying the plant information needs necessary for personnel involved in the management of an accident to diagnose that an accident is in progress, select and implement strategies to prevent or mitigate the accident, and monitor the effectiveness of these strategies. This report describes the methodology and presents an application of this methodology to a Pressurized Water Reactor (PWR) with a large dry containment. A risk-important severe accident sequence for a PWR is used to examine the capability of the existing measurements to supply the necessary information. The method includes an assessment of the effects of the sequence on the measurement availability including the effects of environmental conditions. The information needs and capabilities identified using this approach are also intended to form the basis for more comprehensive information needs assessment performed during the analyses and development of specific strategies for use in accident management prevention and mitigation. 3 refs., 16 figs., 7 tabs.

25819 (NUREG/CR–5513-Vol.2) **Accident management information needs: Volume 2, Appendices A–F.** Hanson, D.J. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Ward, L.W.; Nelson, W.R.; Meyer, O.R. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; EG and G Idaho, Inc., Idaho Falls, ID (USA). Apr 1990. 297p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (EGG–2592-Vol.2). Available from NTIS, PC A13/MF A01 - GPO; OSTI; INIS.

The tables contained in this Appendix A describe the information needs for a pressurized water reactor (PWR) with a large, dry containment. To identify these information needs, the branch points in the safety objective trees were examined to decide what information is necessary to (a) determine the status of the safety functions in the plant, i.e., whether the safety functions are being adequately maintained within predetermined limits, (b) identify plant behavior (mechanisms) or precursors to this behavior which indicate that a challenge to plant safety is occurring or is imminent, and (c) select strategies that will prevent or mitigate this plant behavior and monitor the implementation and effectiveness of these strategies. The information needs for the challenges to the safety functions are not

examined since the summation of the information needs for all mechanisms associated with a challenge comprise the information needs for the challenge itself.

25820 (NUREG/IA–0012) **RELAP/MOD2 calculations of OECD-LOFT test LP-SB-01.** Hall, P.C. (Central Electricity Generating Board, Barnwood (UK)); Brown, G. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Central Electricity Generating Board, Barnwood (UK). Jan 1990. 38p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

To assist CEGB in assessing the capabilities and status of RELAP5/MOD2, the code has been used to simulate SBLOCA test LP-SB-01 carried out in the LOFT experimental reactor under the OECD LOFT programme. This test simulated a 1.0% hot leg break in a PWR, with early tripping of the primary coolant circulating pumps. This report compares the results of the RELAP5/MOD2 analysis with experimental measurements. 19 figs., 2 tabs.

25821 (ORNL/FTR–3545) **[COMEDIE program review and fission product transport in MHTGR reactor]: Foreign trip report, February 23, 1990–March 1, 1990.** Stansfield, O.M. Oak Ridge National Lab., TN (USA). 15 Mar 1990. 23p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90008700. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The subcontract between Martin Marietta Energy Systems, Inc., and the CEA provides for the refurbishment of the high pressure COMEDIE test loop in the SILOE reactor and a series of experiments to characterize fission product lift-off from MHTGR heat exchanger surfaces under several depressurization accident scenarios. The data will contribute to the validation of models and codes used to predict fission product transport in the MHTGR. In the meeting at CEA headquarters in Paris the program schedule and preparation for the DCAA and Quality Assurance audits were discussed. Long-range interest in expanded participation in the gas-cooled reactor technology Umbrella Agreement was also expressed by the CEA. At the CENG, in Grenoble, technical details on the loop design, fabrication components, development of test procedures, and preparation for the DOE quality assurance (QA) audit in May were discussed. After significant delays in CY 1989 it appears that good progress is being made in CY 1990 and the first major test will be initiated by December. An extensive list of agreements and commitments was generated to facilitate the coordination and planning of future work. 2 figs., 2 tabs.

25822 (ORNL/TM–10071/R2) **Cost estimate guidelines for advanced nuclear power technologies.** Delene, J.G.; Hudson, C.R. II. Oak Ridge National Lab., TN (USA). Mar 1990. 160p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90010221. Available from NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.

To make comparative assessments of competing technologies, consistent ground rules must be applied when developing cost estimates. This document provides a uniform set of assumptions, ground rules, and requirements that can be used in developing cost estimates for advanced nuclear power technologies. 10 refs., 8 figs., 32 tabs.

25823 (SDK–3509-01) **Numeric studies on the fracture characteristics in the ligament of the experimental container BVZ070. Final report.** Rensch, H.J.; Lohmeyer, B.; Hofmann, H. SDK Ingenieurunternehmen fuer Spezielle Statik, Dynamik und Konstruktion, Loerrach (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Apr 1987. 72p. (In German). Contract BMFT 1500 717. Order Number DE90767249. Available from NTIS (US Sales Only), PC A04/MF A01.

A detailed non-linear, elasto-plastic analysis up to bursting pressure was carried out at the test container BVZ070 of 20MnMoNi55 with a longitudinal undercut milled at the internal surface. It included the determination of the physical state of stress and deformation within the notch area, the propagation of the plastic zones and the development of the crack opening, crack tip opening, energy release rate or the J integral. An appropriate three-dimensional calculation model was generated on the basis of these findings for the main part of the studies. (DG).

25824 (SIS–1989:4) **Accident on board of Sovjet submarine ECHO II: Alert measures, ra iodine release and consequences.** Backe, S. Statens Inst. for Straalehygiene, Oslo (Norway). 1989. 33p. (In Norwegian). Order Number DE90623063. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

On 26 June 1989 a Sovjet nuclear submarine met with a reactor accident in the Norwegian Sea, caused by breakdown in the primary coolant circuit. The report describes the emergency response in Norway, and data are given on radioactivity in the air. Calculations limit the inhalation of radioactive iodine for the population in northern Norway to 1 Bq. The highest dose to the thyroid gland of crew members on Norwegian surface vessels is estimated to 1.6 mGy. It is concluded that individual exposure in Norway due to the accident is negligible. 11 refs.; 5 figs.; 8 tabs.

25825 (WSRC-RP–89-770) **Nuclear heating in He-3 fast SCRAM rods.** Baumann, N.P.; Flach, G.P. Westinghouse Savannah River Co., Aiken, SC (USA). Sep 1989. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009302. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Nuclear heating occurs in the He-3 fill gas of the fast SCRAM rods as a result of the very neutron captures which make the rods operative. This heating gives rise to a pressure rise within the rod. If severe enough this heating could present a structural problem, but more importantly the pressurization always causes a partial backflow of the fill gas. This, in turn, reduces the residual gas content and thus reduces the effectiveness of the rod. If enough gas were expelled, the rod would no longer have the required reactivity shutdown margin. This memorandum discusses the bases for determining the heat input and estimating the resultant temperatures, pressures, and backflows to be expected under various assumed design and operational conditions. A method for mitigating the effect by means of heat-conducting fins on the interior surface of the rods is discussed and evaluated. 5 refs.

25826 (WSRC-RP–89-958) **Computer simulation of severe accidents for Savannah River reactors using SCDAP/RELAP5.** Ades, M.J.; Gregory, M.V.; Church, J.P.; Wooten, L.A. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-900494–4: 1990 SCS Eastern multiconference, Nashville, TN (USA), 23-29 Apr 1990). Order Number DE90009293. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper provides a review of the theoretical models developed to simulate the unique core response of SRS reactors under postulated severe accident conditions. The models were implemented into the SCDAP/RELAP5 computer code to analyze SRS reactor core response. The analysis results show that the core response models developed provide a valuable approach for SRS severe accident analysis. Benchmarking of these data is planned as a part of the SRS code assessment effort.

25827 (WSRC-RP–89-1223) **TRIMPWR: A post processor for TRIMHX.** Trumble, E.F. Westinghouse Savannah River Co., Aiken, SC (USA). Nov 1989. 32p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009294. Available from NTIS, PC A03/MF A01 - OSTI.

The TRIMPWR code has been developed as a post processor for TRIMHX (transient 3D diffusion code) in support of the reactor limits program. TRIMPWR is designed to produce JOSHUA files containing: core power as a function of time, assembly power by hex as a function of time, assembly power post peaking as a function of time, and axial power shapes for each assembly as a function of time (formatted for use by the FLOWTRAN code) from the output of a TRIMHX run. In an attempt to simplify the reactor limits process by reducing the number of assemblies which must be run through FLOWTRAN, TRIMPWR also sorts the assemblies by the product of the power post peaking and the maximum normalized axial power density for each assembly. This follows from the assumption that those assemblies having the maximum value of this product will have the most restrictive limits.

25828 (WSRC-RP–89-1311) **Final summary report for 1989 inservice inspection (ISI) of SRS [Savannah River Site] 100-P Reactor tank.** Morrison, J.M.; Loibl, M.W. Westinghouse Savannah River Co., Aiken, SC (USA). 15 Dec 1989. 61p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009277. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The integrity of the SRS reactor tanks is a key factor affecting their suitability for continued service since, unlike the external piping system and components, the tanks are virtually irreplaceable. Cracking in various areas of the process water piping systems has occurred beginning in 1960 as a result of several degradation mechanisms, chiefly intergranular stress corrosion cracking (IGSCC) and chloride-induced transgranular cracking. IGSCC, currently the primary degradation mechanism, also occurred in the "knuckle" region (tank wall-to-bottom tube sheet transition piece) unique to C Reactor and was eventually responsible for that reactor being deactivated in 1985. A program of visual examinations of the SRS reactor tanks was initiated in 1968, which used a specially designed immersible periscope. Under that program the condition of the accessible tank welds and associated heat affected zones (HAZ) was evaluated on a five-year frequency. Prior to 1986, the scope of these inspections comprised approximately 20 percent of the accessible weld area. In late 1986 and early 1987 the scope of the inspections was expanded and a 100 percent visual inspection of accessible welds was performed of the P-, L-, and K-Reactor tanks. Supplemental dye penetrant examinations were performed in L Reactor on selected areas which showed visual indications. No evidence of cracking was detected in any of these inspections of the P-, L-, and K-Reactor tanks. 17 refs., 7 figs.

24 POWER TRANSMISSION AND DISTRIBUTION

2401 Power Systems

Refer also to citation(s) 25658, 26450

25829 (ENEA-RT-DISP–89-06) **Overview on some functional issues related to the uninterruptible power systems design.** Grasselli, U.; Ranieri, R. Rome Univ. (Italy); ENEA, Rome (Italy). Direzione Sicurezza Nucleare e Protezione Sanitaria. Nov 1989. 13p. (RT/DISP–89-6). Order Number DE90764324. Available from NTIS (US Sales Only), PC A03.

The adequacy of uninterruptible power system (UPS) design is strictly connected to the achievement of a complete harmonization between the functional characteristics of sub-systems composing the UPS, as well as between these and the UPS input and output functional interfaces. This harmonization process involves many issues, such as: - selection of the UPS structure between the various applicable alternative solutions; - engineering of the UPS input and output distribution system architecture; - in-depth analysis of the static and dynamic load requirements; - definition and evaluation of the UPS operational environmental conditions; - selection and sizing of all the components included within the influence input and output UPS functional and physical interfaces. The paper gives an overview of a possible methodology for the analysis of these issues in terms of UPS interface aspects. Reference is made to UPS load needs, specifically, to those of the typical safety users of nuclear power plants. The proposed approaches are based on a rigorous procedure which gives results suitable for performing a failure mode and effect study fully in compliance with the recommendations of applicable IEC codes.

25830 (EPRI-EL–6769) **Decomposition of linear programs using concurrent processing on multicomputers: Final report.** Ho, J.K. (Tennessee Univ., Knoxville, TN (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Tennessee Univ., Knoxville, TN (USA). c Mar 1990. 118p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This project is concerned with the distributed optimization of block-angular linear programming (LP) models using concurrent processing on multicomputers. The approach we use is that of Dantzig-Wolfe decomposition (DWD). The decomposition of an LP with R blocks is viewed as a coordination of a price-generating process (the Master problem) and R independent proposal-generating processes (the subproblems) towards a global objective. Each of these R + 1 processes is represented by one processor (node) in the multicomputer. The concurrent and asynchronous nature of a distributed system opens up the possibility of a variety of schemes in controlling the flow and utilization of information in the price-proposal coordination process. This provides not only the opportunity for speedup in Dantzig-Wolfe decomposition-based algorithms (DWDA), but also the prospect of truly distributed optimization models where the data for each subsystem is kept and maintained locally and optimization of the entire system is achieved by solely exchanging price and proposal information. An information scheme in distributed DWDA controls the timing of the availability and utilization of the coordinating information. This project investigates four information control schemes: Basic Information Scheme (BIS), Early Termination Information Scheme (ETIS), Early Start Information Scheme (ESIS) and Intermediate Prices Information Scheme (IPIS). A selection of problems are used to test such schemes in the environment of concurrent processing. The emphasis is on the underlying factors that determine the behavior of the information schemes so that guidelines can be developed to aid in the implementation of distributed DWDA for application on optimization problems arising from power systems planning and operations. 46 refs., 17 figs., 23 tabs.

2402 Power System Networks, Transmission and Distribution

Refer also to citation(s) 26003

25831 (CONF-8905297–1) **Performance of multi-chamber HV circuit-breakers during capacitive current switching under pollution conditions.** Bargigia, A.; Aldrovandi, G.; Emolumento, E.; Perin, D. Ente Nazionale per l'Energia Elettrica, Milan (Italy); Shinetsu Chemical Industry Co. Ltd., Takefu, Fukui (Japan). Mar 1989. 15p. From CIGRE SC 13; Sarajevo (Yugoslavia); May 1989. Order Number DE90764278. Available from NTIS (US Sales Only), PC A03/MF A01.

Report presented at the Colloquium of CIGRE SC 13 (Sarajevo, May 1989).

The problem of the performance of HV circuit-breakers under pollution conditions is peculiar of multi-chamber breakers because the voltage distribution between each chamber can result very uneven due to the presence, on the insulating surfaces of insulators, of a pollution layer that becomes conductive when moisted by for, dew of light mist. The alternation of the voltage distribution between each breaking unit causes an overstress mainly on one unit and in certain circumstances may lead to restrike during breaking operation. Moreover it could give rise to failed interruption, restrike during the intermediate post-interruption period and following 'opn-circuit' period, as well as greater pre-arcing time during the making current operation. Taking into account the peculiarity of the phenomena experimental laboratory tests were conducted to help quantify the above discussed problems with more accuracy. A preliminary capacitive current breaking test under pollution conditions was carried out in a high power laboratory, mainly to measure the actual voltage distribution between each chamber. The test was performed on two-chamber circuit-breaker poles for a 245 kV rated voltage systems.

25832 (ENEL–420.560.1) **Most recent developments in surge arresters testing.** Bargigia, A.; de Nigris, M.; Masetti, C. Ente Nazionale per l'Energia Elettrica, Milan (Italy); Shinetsu Chemical Industry Co. Ltd., Takefu, Fukui (Japan). Apr 1989. 51p. (CONF-8904268–2: 56. international conference of Doble Clients, Boston, MA (USA), 10 Apr 1989). Order Number DE90764326. Available from NTIS (US Sales Only), PC A04/MF A01.

Paper presented at 56th annual international conference of Doble Clients (Boston, 10-14 Apr 1989).

Even though surge arresters are often considered to be relatively trouble-free components, failures of both gap and metal-oxide types have been reported. This paper illustrates the most recent

laboratory and field tests developed in Italy for such components. Particular attention is given to the contamination and simulated ageing tests designed to verify the performance of the new-generation of metal-oxide mostly zinc-oxide surge arresters. At first, the structure and operation of modern surge arresters (conventional and metal-oxide) are briefly recalled. Preliminary characterization tests on surge arresters are described, together with qualitative analysis of the pollution (i.e. salt fog) impact and of accelerated ageing. The subsequent service experience is examined and causes for electrical failures are evidenced. Finally, the results of further laboratory investigations deriving from service experience and of development work on field monitoring and control systems are presented.

25833 (ENEL–420.784/2) **Type test for the converter station power components of the SACOI 2 HVCD link.** Boccassini, G.; Tietz, P.; Mazza, G.P.; Tontini, G.; Testi, G.; Urbanek, J. Ansaldo SpA, Genoa (Italy); Ente Nazionale per l'Energia Elettrica, Milan (Italy); Shinetsu Chemical Industry Co. Ltd., Takefu, Fukui (Japan). Jun 1989. 20p. Order Number DE90764280. Available from NTIS (US Sales Only), PC A03/MF A01.

The existing monopolar SACOI HVDC link between Sardinia and mainland Italy through Corsica is in the process of being upgraded by ENEL. Two new 300 MW, 200 KVdc terminal stations equipped with thyristor valve twelve-pulse converters are, in the coming years, to take the place of the two present 200 MW, 200 kVdc ones, which were equipped with mercury arc valves. Most of the converter station power components have already been manufactured and tested, and their installation is in progress. In this paper, the work done on the type testing of such components is briefly recalled and the basic criteria adopted in the absence of standards are shown.

25834 (ENEL–440.950/1) **System studies to be undertaken by the utility during planning, design and construction of a DC link.** Manzoni, G.; Pincella, C. Ente Nazionale per l'Energia Elettrica, Milan (Italy). May 1989. 9p. Order Number DE90764279. Available from NTIS (US Sales Only), PC A02/MF A01.

This paper examines the approach that a utility may adopt regarding system studies necessary for the choice, design and construction of a DC transmission system. The computational tools necessary for the above studies are also indicated. The examples and considerations reported are based on the experience acquired by ENEL (Italian Electricity Board) within the framework of studies concerning several foreign DC systems and, mainly, the SACOI 2 project (mainland Italy-Corsica-Sardinia link).

25835 (EPRI-EL–6680-Vol.1) **CRAFT: On-line expert system for customer restoration and fault testing: Volume 1, Control center implementation and testing: Final report.** Liu, C.-C. (Washington Univ., Seattle, WA (USA). Dept. of Electrical Engineering); Damborg, M.J. Electric Power Research Inst., Palo Alto, CA (USA); Washington Univ., Seattle, WA (USA). Dept. of Electrical Engineering. c Mar 1990. 44p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The purpose of the rule-based expert system, CRAFT (Customer Restoration And Fault Testing) is to assist power dispatchers with fault isolation and customer restoration in multi-tapped transmission lines equipped with automatic switches. CRAFT is able to perform reasoning to derive the status of unsupervised automatic switches. The CRAFT system is operating on-line at the control center of Puget Sound Power and Light Company (Puget Power). The expert system was developed by the University of Washington (UW) under the sponsorship of EPRI with cofunding from the National Science Foundation and Puget Power. The on-line CRAFT system is implemented on an expert system computer data-linked to the SCADA computer in the control center. In Puget Power's control center, a Micro VAX II computer is linked to the MODCOMP CLASSIC II SCADA computer to perform the functions of fault testing and substation restoration. The CRAFT system contains approximately 450 rules written in the rule-based language, OPS83. The typical response time of CRAFT is approximately 13 seconds. 15 refs., 17 figs., 2 tabs.

25836 (EPRI-EL–6761) **Bubble generation during transformer overload: Final report.** Oommen, T.V. (Westinghouse ABB Power T and D Co., Sharon, PA (USA). Materials and Mfg. Technology Dept.). Electric Power Research Inst., Palo Alto, CA (USA); Westinghouse ABB Power T and D Co., Sharon, PA (USA). Materials and Mfg. Technology Dept. c Mar 1990. 64p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Bubble generation in transformers has been demonstrated under certain overload conditions. The release of large quantities of bubbles would pose a dielectric breakdown hazard. A bubble prediction model developed under EPRI Project 1289-4 attempts to predict the bubble evolution temperature under different overload conditions. This report details a verification study undertaken to confirm the validity of the above model using coil structures subjected to overload conditions. The test variables included moisture in paper insulation, gas content in oil, and the type of oil preservation system. Two aged coils were also tested. The results indicated that the observed bubble temperatures were close to the predicted temperatures for models with low initial gas content in the oil. The predicted temperatures were significantly lower than the observed temperatures for models with high gas content. Some explanations are provided for the anomalous behavior at high gas levels in oil. It is suggested that the dissolved gas content is not a significant factor in bubble evolution. The dominant factor in bubble evolution appears to be the water vapor pressure which must reach critical levels before bubbles can be released. Further study is needed to make a meaningful revision of the bubble prediction model. 8 refs., 13 figs., 11 tabs.

25837 (EPRI-EL–6763) **Field evaluation of 69-kV outdoor Polysil® insulators: Final report.** Richenbacher, A.G. (Pennsylvania Power and Light Co., Allentown, PA (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Pennsylvania Power and Light Co., Allentown, PA (USA). c Mar 1990. 46p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report, together with previous interim reports, documents and summarizes the field performance of 69 kV Polysil® insulators during the field trial period from January, 1983 to December, 1988. These insulators were manufactured for the Electric Power Research Institute by Lindsey Industries in 1979. A description of the insulator development and manufacturing process is contained in the EPRI Final Report EL1281-1. Following their manufacture, the insulators were delivered, in the form of test racks of 17 Polysil® insulators and one porcelain insulator, to twelve United States utilities and the Instituto de Investigaciones Electricas (IIE) in Mexico. These racks were subsequently installed and energized at twenty-five test sites during the latter half of 1979 and early 1980 by the project participants for the purpose of analyzing the outdoor field performance of these insulators and comparing the relative effect on performance of variations in composition, coating, electrical grading method, and shape represented by individual insulators within the test racks. This report documents the effects of the various Polysil® insulator parameters on electrical performance in the field over a specific period of 6 years. However, the insulators had been energized for approximately 3 years prior to the initiation of this project and, although specific performance data is not available for that time period, the overall effects of field exposure for that additional time period (total of 9 years) are seen in the results of this report. 3 refs., 23 figs., 9 tabs.

25838 (ORNL/CON–296) **Implementation and enforcement of Bonneville's Model Conservation Standards within early adopting jurisdictions.** Brown, M.A.; Cohn, S.M.; Kolb, J.O. Oak Ridge National Lab., TN (USA). Feb 1990. 96p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC05-84OR21400. Order Number DE90010217. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report evaluates the enforcement methods and costs of eight jurisdictions participating in Bonneville Power Administration's Early Adopter Program. This program was initiated in 1986 to help jurisdictions within the Pacific Northwest adopt energy-efficient, Model Conservation Standards (MCS) for new residential construction. The objectives of this evaluation are: to document the strategies used by Early Adopters to implement the MCS in their jurisdictions; to estimate the incremental time and cost associated

with enforcing the MCS, and to identify changes in enforcement activities and costs that occurred between 1987 and 1989. Each of the eight jurisdictions used either an "interactive" or "code-enforcement" strategy too implement the MCS. All three of the jurisdictions selecting interactive strategies were located in Idaho. The fourth Idaho jurisdiction used a code-enforcement strategy as did the four Washington jurisdictions. The total incremental time spent on MCS enforcement efforts for interactive jurisdictions in our sample was almost twice that of code-enforcement jurisdictions. On average, interactive jurisdictions devoted approximately 9 hours on MCS-related activities for single-family (SF) homes, excluding travel time; code-enforcement jurisdictions spent 5 hours. For both strategies, approximately 40% is spent on inspections, another 40% on plan review, and the remaining 20% is spent providing technical assistance.

25839 (ORNL/FTR–3568) **[Mid-term evaluation of the Central America Rural Electrification Support program]: Foreign trip report, March 5–17, 1990.** Perlack, R.D. Oak Ridge National Lab., TN (USA). 30 Mar 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009295. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Oak Ridge National Laboratory (ORNL) was requested by Regional Office for Central America and Panama (ROCAP) to conduct a mid-term evaluation of the CARES project. Numerous meetings were held with National Rural Electric Cooperative Association (NRECA) staff, ROCAP staff, and local officials in Guatemala, Honduras, and Belize. In general, the CARES project has been quite successful in a number of key areas as well as in soliciting support from utilities and US Agency for International Development (US-AID) Missions. Changes were recommended in the area of report writing and some management activities. It was also recommended that any new activities be considered in the light of the availability of local personnel.

25840 (ORNL/FTR–3569) **[Monitoring and evaluation of the Central American Rural Electrification Program]: Foreign trip report, March 4–15, 1990.** Garcia, A. III (Texas A and M Univ., College Station, TX (USA)). Oak Ridge National Lab., TN (USA). 20 Mar 1990. 10p. Sponsored by U.S. Agency for International Development. DOE Contract AC05-84OR21400. Order Number DE90009262. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

CARES has been successful in leveraging its effort with similar programs in other countries. NRECA has done an exceptional job of coordinating the related activities of other AID contracts. The informal lines of communication appear to work well with a relaxed and productive environment evident. ROCAP has expressed confidence in the ability of NRECA to carry out the Workplan successfully. Recent initiatives by Mr. Funes in the area of indicators are seen by the review team as a positive and mutual step to articulate specific goals and accomplishments. Communication and coordination among the ROCAP staff and the local AID Mission appears to have improved since last mentioned in the Engineering Standards Review. This is especially true in Guatemala and Costa Rica. Better reporting procedures would facilitate NRECA-ROCAP-AID Mission communication. Impressive progress has been made in the way local officials approach rural electrification. This is very evident in the areas of engineering design and the productive uses campaign. The Planning and Engineering sections of INDE and CEL rapidly adopted the new mechanical strength based standards as reasonable design solutions. Similarly, productive uses has received much greater attention by all of the various divisions of the utilities in El Salvador, Guatemala and Costa Rica. This was not the case previous to the CARES Project. The final report specifically addresses several areas that should be de-emphasized or given more attention. 26 refs.

25841 (PNL-SA–17792) **Space power generation and distribution.** Coomes, E.P.; Widrig, R.D.; Johnson, B.M. Pacific Northwest Lab., Richland, WA (USA). Jan 1990. 5p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-900109–24: 7. symposium on space nuclear power systems, Albuquerque, NM (USA), 7-11 Jan 1990). Order Number DE90008676. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Energy is the key to mankind's future exploration, development, and utilization of space. In his address commemorating the 20 anniversary of the APOLLO-II lunar landing, President Bush outlined the objectives of the United States Space Program. The priorities are the space station, a lunar base, and a manned Mars mission. The availability of safe, reliable, and lightweight energy sources in space provides the foundation to support the missions that accomplish the space program objectives Bush presented. However, the availability of power in space is currently constrained by the "Ever-Ready Energizer" approach: individual power sources tailored to each satellite for each mission. This document describes an alternative approach known as power beaming, which integrates power generation and distribution, opening space to many new applications. Power beaming is the basis for a completely new space power architecture and a fully integrated transportable space power infrastructure. The power-beaming architecture supporting near-Earth missions can be replicated as mankind explores farther into the solar system. A power-beaming architecture would support manned lunar activities including the establishment of a permanent base on the moon. As mankind ventures farther to Mars and even the asteroids, a power-beaming space power architecture would support these activities as well. 1 fig.

2403 Power Transmission Lines and Cables

Refer also to citation(s) 25843

25842 (EPRI-EL–6760) **Evaluation of pipe-type cable joint restraint systems: Final report.** Silver, D.A. (Pirelli Cable Corp., Lexington, SC (USA)); Seman, G.W. Electric Power Research Inst., Palo Alto, CA (USA); Pirelli Cable Corp., Lexington, SC (USA). c Mar 1990. 47p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

the purpose of this project was to evaluate two systems for restraining the movement of 345kV high-pressure oil-filled (HPOF) cable joints during load cycling. Problems with joints and adjacent cables due to thermomechanical bending (TMB) experienced by the Consolidated Edison Company of New York and Public Service Electric & Gas Company of New Jersey are reviewed. Some approaches to reducing or preventing TMB induced damage to HPOF pipe type cable joints are discussed. The design and operation of a special test apparatus for simulating TMB effects under laboratory conditions is described. One of the two joint restraint systems evaluated under this project was developed by PSE&G and employed wedging devices, which could be retrofitted into existing installations, that limited the longitudinal movement of the joints during load cycling. The other system developed by Pirelli Cable Corporation applied the restraining force to the cylindrical portion of the hand applied joint insulation by means of support spiders and steel rods attached to the reducer faces. The test results show that the PSE&G restraint system can effectively limit joint longitudinal movement while causing a minimal amount of mechanical disturbance to the joint stress cones. The test results obtained with the PCC system are inconclusive and indicate that further refinement and testing are required to demonstrate the effectiveness of this promising joint restraint system.

2405 Environmental Aspects

25843 (DOE/EA–0394) **McMinnville area support transmission project: Environmental Assessment.** USDOE Bonneville Power Administration, Portland, OR (USA). Jan 1990. 5p. Sponsored by U.S. DOE Management & Administration. Order Number DE90008993. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This document discusses a project to provide continuing reliable electrical service to the McMinnville, Oregon, area. BPA proposes to participate with the City of McMinnville Water and Light Department in constructing a new 230-kilovolt transmission line and substation. BPA has prepared an environmental assessment evaluating the proposed project. Reasons that constructing the line and

substation would not cause significant environmental impact include: consistency with local land use plans, consistency of appearance with existing transmission and manufacturing facilities in the area, only slight effect on farmland, and avoidance of wetlands and other environmentally sensitive areas. A finding is included that there is no practicable alternative to locating the project within a 100-year floodplain. 1 fig.

2406 Legislation and Regulations

Refer also to citation(s) 25838

2407 Economic, Industrial, and Business Aspects

Refer also to citation(s) 25840, 25925

25 ENERGY STORAGE

2506 Thermal

Refer also to citation(s) 25735

25844 (ORNL/TM–11492) **Thermal energy storage technical progress report, April 1988–March 1989.** Tomlinson, J.J.; Kedl, R.J. Oak Ridge National Lab., TN (USA). Mar 1990. 82p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90010223. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The Department of Energy (DOE) is charged with supporting development of technologies that improve the energy and environmental posture of the nation in terms of increased energy efficiency and fuel switching strategies that emphasize greater reliance on indigenous energy resources. As an enabling technique for utilization of renewable energy resources and for improvement of utility load factors, thermal energy storage (TES) can play a vital role. Progress in the development of TES technologies under Oak Ridge National Laboratory's (ORNL) TES Program for the period April 1988 to March 1989 is reported. Each of the projects in the diurnal and industrial TES subprogram is discussed, and their integrated role in support of major application areas is defined. 13 refs., 33 figs., 2 tabs.

2508 Chemical

Refer also to citation(s) 26255

2509 Batteries

Refer also to citation(s) 25657, 25659, 26115

25845 (AD-A–216030/7/XAB) **Performance of superconductive oxides as cathodes for lithium rechargeable batteries. Technical report, July 1988-October 1989.** Owens, B.B.; Munshi, M.Z.; Prasad, P.S.; Smyrl, W.H.; Jones, W.K. Minnesota Univ., Minneapolis, MN (USA). Dept. of Chemical Engineering and Materials Science. 23 Oct 1989. 3p. (TR–18-ONR). Available from NTIS, PC A01/MF A01.

The superconducting oxides, yttrium barium copper oxide (A) and neodymium copper oxide (B) were fabricated into cathodes for lithium nonaqueous batteries. The cathode limited cells had electrolytes of 1M $LiClO_4$ or $LiAsF_6$ in propylene carbonate or 2-methyl-tetrahydrofuran and were hermetically sealed in stainless steel case-positive cans. The initial open circuit potentials were in the range of 3.0-3.5 volts for all cell types. The potentials of both type A and B cells with oxides prepared in an atmosphere of O_2 were about 200mV greater than those for cathodes that have been prepared in an N2 atmosphere. Cycle and capacity test results are presented.

25846 (AD-A–216037/2/XAB) **Cell performance of ultrathin polymer-cathode systems: Part 1. Anion intercalating polymer cathode. Technical report, July 1988-October 1989.** Naoi, K.; Owens, B.B.; Smyrl, W.H. Minnesota Univ., Minneapolis, MN (USA). Dept. of Chemical Engineering and Materials Science. 1 Nov 1989. 20p. (TR–20-ONR). Available from NTIS, PC A03/MF A01.

Theoretical energy and power density values for thin film Li/liquid electrolyte/polymer cell systems were calculated by designing a specific cell model for a both prismatic cell with only the basic cell element (no hardware) and a bipolar-design cell with some practical hardware. The cell performance is compared for three different cathode polymer materials, viz., polyaniline, polypyrrole, and polyvinylferrocene. The energy and power densities are estimated as a function of cathode thickness, active cell area, and initial concentration of electrolyte for very thin cathode films (cathode thickness). For the practical cell, the authors used a bipolar design, for which the energy and the power were calculated also as a function of the number of bipolar units (X).

25847 (AD-A–216038/0/XAB) **Application of polymer electrolytes to lithium batteries. Technical report, July 1988-October 1989.** Owens, B.B.; Munshi, M.Z.; Prasad, P.S. Minnesota Univ., Minneapolis, MN (USA). Dept. of Chemical Engineering and Materials Science. 23 Oct 1989. 3p. (TR–19-ONR). Available from NTIS, PC A01/MF A01.

Ever since the publication of Fenton and Wright's work on ionically conducting polymers in 1973, the potential application of solid polymer electrolytes to solid state lithium batteries has lead to an extensive investigation of their transport and electrochemical properties. Recent modeling studies on lithium/insertion cathode cells, including the design scale-up for both unipolar and bipolar configurations indicates the possibility of achieving high energy and power densities well in excess of the present advanced batteries. The recently reported work on polymer electrolyte batteries that operate from -20 C to +100 C demonstrates the utility of this new class of lithium batteries.

25848 (ANL/PPRNT–90-210) **In situ monitoring of electrode processes by laser Raman scattering: Part 1, Studies on surface phases formed on lead electrode at constant potentials in 0.1N sulfuric acid.** Varma, R. Argonne National Lab., IL (USA). 1982. 34p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. Order Number DE90009153. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Laser Raman spectroscopy has been used as an in situ analytical tool for characterizing the structure and composition of surface layers on lead electrodes electrochemically formed in 0.1N H_2SO_4. The reported measurements allowed identification of the solid surface phases formed on lead over a range of potentials (−0.4 to 1.4 V vs Hg/Hg_2SO_4) in 0.1N H_2SO_4. The observed electrochemical transformations of the lead electrode surface layers should be similar to those taking place on the positive plate of lead-acid batteries during charge and discharge and, therefore, should be of benefit in designing lead-acid-battery positive plates of improved performance. 25 refs., 11 figs., 3 tabs.

25849 (Juel-Conf–77, pp. 455-466) **Metallic lithium as anode material in power sources.** Pejovnik, S. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia). Dept. of Chemistry); Gaberscek, M.; Jamnik, J.; Metelko, D. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

An overview of contemporary research activities of the Power Sources Laboratory at Boris Kidric Institute of Chemistry, Ljubljana is presented. At studying the lithium passive layer behavior a special emphasis was given on following topics: 1. Comparison between results obtained by using the A.C. impedance spectroscopy and those obtained by the pulse method. 2. On the basis of experimental results new models were given in order to explain migration and polarisation phenomena within the passive layer. 3. The influence of electrolyte composition on the passive layer properties was studied by using electrochemical as well as optical methods. (orig.).

25850 Li-reactivity of silicate glasses: influence of glass composition. . Cieslak, W.R. (Sandia National Labs. , Albuquerque, NM (US)); Reinhardt, F.W.; Maschhoff, B.L.; Lee, P.A.; Armstrong, N.R. pp. 408 of Proceedings of the symposium on materials and processes for lithium batteries. Abraham, K.M.; Owens, B.B. The Electrochemical Society, Pennington, NJ (USA) (1989). (CONF-8810205--: Symposium on materials and processes for lithium batteries, Chicago, IL (USA), 9-14 Oct 1988).

This investigation has concentrated on the reactivity of aluminosilicate glasses with lithium, in consideration of applications for separator papers in Li/$SOCl_2$ cells. Although the silicate matrix is unstable with respect to lithium, additives to the glass can decrease or increase the overall glass reactivity. The authors show that, even in the presence of a stabilizing aluminum addition, sodium oxide exchange and reduction occurs immediately, causing increased tendency to react as compared to pure silica. Addition of calcium rather than sodium to the glass, however, allows for a material with increased stability as compared to silica.

25851 Chemical overcharge and overdischarge protection for li-alloy/transition-metal sulfide cells. Redey, L. (Argonne National Lab., Chemical Technology Div., Electrochemical Technology Program, (US)). pp. 408 of Proceedings of the symposium on materials and processes for lithium batteries. Abraham, K.M.; Owens, B.B. The Electrochemical Society, Pennington, NJ (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-8810205--: Symposium on materials and processes for lithium batteries, Chicago, IL (USA), 9-14 Oct 1988).

Chemical overcharge protection based on a controlled self-discharge method has been developed to prevent detrimental overcharge of Li-alloy/MS_x cells. Experiments with LiA1Si/LiF-LiC1-LiBr-MgO/FeS and LiA1Si/LiC1-LiBr-KBr-MgO/FeS cells are described. Tolerance for 10 mA/cm^2 overcharge current density has been achieved. Results of cell voltage and electrode potential measurements on test cells during normal cycling, overcharge, and overdischarge provide the basis to develop the theory of the involved protecting mechanisms and to elaborate the design principles of protected prismatic and bipolar compact cells.

25852 Development of overcharge tolerance in li/fes and LI/FeS(sub 2) cells. Kaun, T D. (Argonne, IL (US)); Holifield, T.F.; Nigohosian, M.; Nelson, P.A. pp. 408 of Proceedings of the symposium on materials and processes for lithium batteries. Abraham, K.M.; Owens, B.B. The Electrochemical Society, Pennington, NJ (USA) (1989). (CONF-8810205--: Symposium on materials and processes for lithium batteries, Chicago, IL (USA), 9-14 Oct 1988).

The authors discuss an innovative application of a self-discharge mechanism for molten-electrolyte Li-alloy/FeS_x cells has led to the development of overcharge-tolerant cells. Conventional Li-alloy/FeS_x battery cells require an electronic charger/equalizer. Two versions of the cell have been demonstrated: LiAl + 10 Mol% $Li_5Al_5Fe_2$/LiCl-LiBr-KBr (BN, MgO)/FeS_2 (operated at 400°C) and LiAl + 10 mol% Li_5 Fe_2/LiF-LiCl-LiBr(MgO)/FeS (operated at 475°C. These cells exhibit a unique combination of overcharge capacity and extended trickle-charge tolerance at 2-5 mA/cm^2. The basis for the self-discharge is diffusion of reduced lithium species across the separator by a lithium-shuttle mechanism that is controlled by the Li-activity of the Li-alloy electrode. The overcharge tolerance rates are sufficient for battery cells to exhibit built-in charge/equalization.

25853 Lithium/disulfide cells capable of long cycle life. Kaun, T.D. (Chemical Technology Div., Argonne National Lab., Argonne, IL (US)); Holfield, T.F.; DeLuca, W.H. pp. 408 of Proceedings of the symposium on materials and processes for lithium batteries. Abraham, K.M.; Owens, B.B. The Electrochemical Society, Pennington, NJ (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-8810205--: Symposium on materials and processes for lithium batteries, Chicago, IL (USA), 9-14 Oct 1988).

The lithium-alloy/disulfide cell has undergone improvements to provide a very stable, high performance upper-plateau (U.P.) FeS_2 electrode. Prismatic U. P.FeS_2 cell tests (12-24 Ah capacity) with a LiCl-LiBr-KBr eutectic electrolyte have demonstrated 1000 deep discharge cycles at 400°C with less than a 20% drop in capacity and without reduced power capability.

25854 Modeling of sodium/metal chloride batteries. Nelson, P.A. (Argonne National Lab., IL (USA)). pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 3. . IEEE Service Center, Piscataway, NJ (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899249.

The author discusses the performance of sodium/ion chloride cells modeled to determine the effect of a high ratio of solid electrolyte surface area cell capacity. Preliminary studies showed that electrolyte configurations of either multiple tubes joined to a header or compartment flat structures would result in high performance cells. A detailed calculation of performance of 215 Ah cells of the latter configuration resulted in a cell specific energy of 187 Wh/kg and a specific power of 293 W/kg. The calculated performances greatly exceed the experimental accomplishments of conventional cells having a single tubular electrolyte.

25855 Real-time x-radiography of operating sodium/sulfur cells. Davenport, R.L. (Science Applications International Corp., San Diego, CA (USA)); Featherby, M. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 3. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899149.

Real-time x-radiographic studies have been performed on several sodium/sulfur battery cells. The radiography techniques have allowed detailed observation of the processes occurring within the cells in real time, without the need for special cell construction or physical intrusion into the cells. Several new and some unexplained phenomena were seen in the course of the investigations, including a variety of unusual wetting behaviors, bubbling and convection in the liquid components, and effects of cell failure on cooldown. Selected results and observations from the testing are presented and described. Hypothesized explanations for some of the observed behaviors are presented.

25856 Projected costs for sodium-sulfur electric vehicle batteries. Quinn, J.E. (U.S. Department of Energy (US)); Symons, P.C.; Brown, D.R.; Riley, D.J.; Atherton, G.; Rampton, S.C. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 3. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899130.

The authors present cost projections and required selling prices for electric vehicle batteries using sodium-sulfur technology. The projected costs were aggregated from a unit operations level cost analysis. Designs and costs were based on a 69-kWh battery (nominal capacity) and a manufacturing facility producing 6600 batteries per year. The required selling price was estimated to be $112 per kWh. Sensitivities of cost to larger production volumes were also investigated. In addition, an independent team reviewed the work and found the methodology and results consistent with good cost analysis practice.

25857 Status of zinc-bromine battery development at Energy Research Corporation. Leo, A. (Energy Research Corp., Danbury, CT (USA)). pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 3. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899335.

The zinc-bromine battery system is under development in a program which focuses on stationary energy storage applications, such as utility load leveling. After completion of extensive material optimization and basic cell design studies, the work now centers on optimizing the battery system hardware and demonstrating the technology in larger systems. This paper describes development work on a new generation of battery hardware, with a larger active cell area and improved electrolyte flow characteristics. Results of

design studies and battery tests on the new hardware are presented, along with the status of older batteries on test with the baseline hardware.

25858 Sodium sulphur battery development. Stackpool, F.M. (Chloride Silent Power Ltd., Runcorn (UK)); Auzer, W.; McNamee, M.; Mangan, M.F. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 6. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899199.

Chloride Silent Power Limited has been developing the sodium sulfur battery utilizing a cell with a capacity of 10 Ah. Significant benefits have been realized by changing to the small cell concept particularly in regard to freeze thawing of cells and safety under deliberately induced failure. At the same time the performance of the cells has been improved with a reduction in internal resistance and demonstrated long term capacity and resistance stability. In this paper the performance of both individual cells and batteries of up to 960 cells are described.

25859 Method of making a long-life high-current-density cathode from tungsten and iridium powders using a mixture of barium peroxide and a coated emitter as the impregnant. Branovich, L.E.; Smith, B.; Freeman, G.E.; Eckart, D.W. To Department of the Army, Washington, DC (USA). USA Patent Application 7-439,135. 20 Nov 1989. 9p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

A long life high current density cathode is made from a mixture of tungsten and iridium powders by processing the mixture of powders with an activator into a porus billet, and then impregnating the billet with a mixture of barium peroxide and a coated emitter by firing the billet in a dry hydrogen furnace at a temperature at which the impregnant melts.

29 ENERGY PLANNING AND POLICY

25860 (QER--90-01666) **Energy in Quebec, 1988 edition.** Quebec Ministere de l'Energie et des Resources, Quebec, PQ (Canada). 1988. 119p. (MICROLOG--90-01666). Available from PC Ministere de l'energie et des ressources, Direction des communications, 200, chemin Sainte-Foy, 7e etage, Quebec, PQ, CAN G1R 4X7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This annual report compiles all the essential statistical data on Quebec's energy sector, accompanied by analyses of the outstanding facts and trends of the past year. The first part deals with the Quebec energy sector in general, including data and information showing the developments in total energy demand and energy distribution according to sector; the share claimed by each form of energy; a comparison between Quebec's energy consumption and that of the rest of Canada and certain OECD countries; the relative efficiency of energy supply systems in Quebec and Ontario; changes in energy prices; an evaluation of the economic impact of the energy sector; electricity exports; price developments in energy markets; the characteristics of demand; and energy economies. The second part deals with various energy industries, grouped according to the form of energy concerned (electricity, natural gas, oil and alternative energy sources) and energy consumption adjusted for variations in weather. Technical data specifically related to the 1986 energy balance sheet are provided in an appendix, including data on the energy supply structure of Quebec's economy and statistics on the distribution of energy per consumption sector. 55 figs., 65 tabs.

25861 Planning energy mastery work. Laponche, B. *Revue de l'Energie (France),* 40(412): 509-512 (Jun-Jul 1989). (In French).

Energy mastery, from now on, is an indispensable component in every energy policy. Energy mastery work can be planned in a coherent way in four steps or phases, i.e. preparation of a consumption grid and analysis of what determines demand: exploration of future energy demand based on hypotheses concerning economic and social development; scheduling of actions relative to each "triplet" (consumption sub-sector, technique, main participant); follow-up and evaluation of the action. This planning approach must be interactive, iterative and continuous. It is particularly advantageous for planning at the level of a region. A region is a geographic, administrative and political entity which is very suitable for the implementation of energy mastery work.

2901 Energy Analysis and Modeling

Refer also to citation(s) 25927

2902 Economics and Sociology

Refer also to citation(s) 25536, 25631, 25735, 25875, 25903, 25910, 25913, 25915, 25990, 25991, 26014, 26652

25862 (CANWEC--CE02833) **Energy for tomorrow. Division 3: Energy and the economy: Session 3.1: International aspects of energy economics.** L'energie pour demain. Division 3: L'energie et l'economie. . Canadian National Committee, World Energy Conference, Ottawa, ON (Canada). 1989. vp. (CONF-890901--: 14. world energy conference, Montreal (Canada), 17-22 Sep 1989; CE--02833). Available from Canadian National Committee World Energy Conference, Suite 305, 130 Albert Street, Ottawa, ON, CAN K1P 5G4. Prices: $125.00 CAN.

This session of the World Energy Conference highlights the economic aspects of energy development in both developing and developed countries. A total of 10 papers have been abstracted from this session.

25863 (CANWEC--CE02833, pp. 1-19) **Development prospects of east-west energy relations: Report 3.1.6.** Canadian National Committee, World Energy Conference, Ottawa, ON (Canada). 1989. (CONF-890901--: 14. world energy conference, Montreal (Canada), 17-22 Sep 1989; CE--02833). In *Energy for tomorrow. Division 3: Energy and the economy: Session 3.1: International aspects of energy economics.* Available from Canadian National Committee World Energy Conference, Suite 305, 130 Albert Street, Ottawa, ON, CAN K1P 5G4. Prices: $125.00 CAN.

On average, 50% of the revenues of the socialist countries of Eastern Europe from trade with the West are derived from primary energy exports. While this trade had quadrupled between 1973 and 1987, its future and, hence the future of western exports to the East, appear uncertain. The paper discussed the prospects of a better balance between West-East energy technology transfers, of joint ventures in nuclear development and safety and in environmental control techniques, and of trade and cooperation in resource-efficient and environmentally-acceptable energy technologies. The high priority accorded to the rational use of energy and energy conservation in all countries of the region could open up a new chapter of East-West energy relations, particularly if small and medium sized companies, both East and West, were given the possibility of directly cooperating with each other. Failure to seize these opportunities and to reduce the primary energy bias of the export structure of the socialist countries of Eastern Europe would, in last instance, result in an undesirable contraction of East-West economic interchange in general. 9 tabs.

25864 (CANWEC--CE02833, pp. 1-30) **Real and financial flows linked with the international trade in hydrocarbons: Report 3.1.4.** Pauwels, J.P. (National Bank of Belgium (Belgium)); Lauwers, P.H. Canadian National Committee, World Energy Conference, Ottawa, ON (Canada). 1989. (CONF-890901--: 14. world energy conference, Montreal (Canada), 17-22 Sep 1989; CE--02833). In *Energy for tomorrow. Division 3: Energy and the economy: Session 3.1: International aspects of energy economics.* Available from Canadian National Committee World Energy Conference, Suite 305, 130 Albert Street, Ottawa, ON, CAN K1P 5G4. Prices: $125.00 CAN.

This article analyzes the flow in international trade concerning hydrocarbons, both the energetic flows and the non-energetic flow

which form their counterparts (goods and services, revenues, capital movements). The current energetic and non-energetic flows of international trade linked to hydrocarbons have a counterpart in the monetary fields: flows of payment, commercial credits as well as international credit flows and investment flows stemming from the producing countries. Tables are enclosed which provide an overview of both a quantitative and qualitative nature (the type of products and services, the geographic destination and origin, the foreign currencies involved, and the type of investments) of current and monetary flows. Analysis of the net creditor or debtor position of producing countries comprises a study of the claims and liabilities of countries producing hydrocarbons, both regarding the structure of these claims and liabilities (short, medium and long term) and for the currencies used for investing and borrowing. Real as well as monetary flows are influenced by the evolution of hydrocarbon prices and by the adjustment policies followed by both producing and consuming countries. 13 refs., 8 tabs.

25865 (CANWEC–CE02833, pp. 1-14) **Social and economic development and changes in different geographic areas related to various scenarios of energy price: Report 3.1.3.** Curcio, E. (Corporate Development of AGIP SpA (Italy)). Canadian National Committee, World Energy Conference, Ottawa, ON (Canada). 1989. (CONF-890901–: 14. world energy conference, Montreal (Canada), 17-22 Sep 1989; CE–02833). In *Energy for tomorrow. Division 3: Energy and the economy: Session 3.1: International aspects of energy economics.* Available from Canadian National Committee World Energy Conference, Suite 305, 130 Albert Street, Ottawa, ON, CAN K1P 5G4. Prices: $125.00 CAN.

Over the last 15 years, two oil crises and the recent countershock have provided information about the relationships that link the price of oil to the main macroeconomic variables, to ecomomic and energy policies and to the evolution of the social structures and the welfare of populations. There are a number of factors which help to achieve a new type of balance. These comprise the measures enacted by governments with regards to economic and energy policies, the decisions taken by oil companies and the behaviour of individual consumers in satisfying their requirements. The action taken by industrialized countries has proved satisfactory, whereas that taken by oil importing and exporting developing countries in this context has been in a lower key. With the use of econometric models and common basic assumptions, the quantitative macroeconomic effects of the two different real prices on the three groups of countries were calculated. The results comfirmed that industrialized countries are less sensitive, due to the fact that oil plays a less important role in their ecomomic activities. The price of oil has a greater impact on the economic system of oil importing and exporting developing countries, even though the effects are radically different in the two groups.

25866 (CONF-9003123–1) **Incorporating social concerns in environmental impact assessments.** Wolfe, A.K. Oak Ridge National Lab., TN (USA). Mar 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 1990 international meeting of the Society for Applied Anthropology; York (UK); 28 Mar - 1 apr 1990. Order Number DE90009231. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Social impact assessments most often focus on the population-driven impacts of projects. Such impacts may be insignificant when compared with social structural impacts of complex, controversial projects. This set of impacts includes social disruption, social group formation, and stigma effects. The National Environmental Policy Act does not explicitly call for assessment of, and assessors often are reluctant to address, these complex issues. This paper discusses why such impacts are critical to assess and gives examples of how they have been incorporated into environmental assessment documents. 6 refs.

25867 The work of the european investment bank for projects in the energy field. Tabary, P. (Banque Europeenne d'Investissement (Luxembourg)). *Revue de l'Energie (France)*, 40(411): 447-452 (May 1989). (In French).

A banking institution of the European Community, for long-term financing of investments to contribute to reducing structural disparities within the EEC, the European Investment Bank (EIB) has been called upon to take substantial action following the oil shocks to reduce or diversify Europe's energy dependence. The EIB is a non profit institution which makes long term loans in the main community and non community currencies, at the best conditions of the moment, benefitting from the excellent credit standing (AAA) which it enjoys on the markets. In the energy field it finances, up to 50% of the total cost of projects of all sizes, public as well as private, for production, distribution or rational use of energy, including developing domestic resources, importing non petroleum fuels, interconnection of electric power grids or gas pipelines, conversion of control equipment or boilers, insulation, solar panels, etc.

2903 Environment, Health, and Safety

Refer also to citation(s) 25293, 25317, 25318, 25323, 25342, 25345, 25347, 25357, 25430, 25442, 25443, 25444, 25469, 25506, 25608, 25866, 25909, 25921, 26034, 26035, 26585, 26586, 26587, 26588, 26601, 26617, 26619, 26629, 26630, 26631, 26632, 26635, 26638, 26639, 26644, 26645, 26650, 26772, 26773, 26774, 26775, 26780, 26792, 26794, 26795, 26796, 26797, 26801, 26802, 26803, 26804, 26805, 26812, 26813, 26814, 26815, 26817, 26818, 26819, 26820, 26821, 26822, 26823, 26824, 26825, 26826, 26827, 26828, 26829, 26830, 26833, 26834, 26836, 26838, 26936

25868 (PB–90-133067/XAB) **EPA's (Environmental Protection Agency's) research and development program for waste minimization.** Bridges, J.S. Environmental Protection Agency, Cincinnati, OH (USA). Risk Reduction Engineering Lab. 1989. 16p. (EPA–600/D-89/207). Available from NTIS, PC A03/MF A01.

See also PB–89-181234.

The paper was presented at the 7th Annual Virginia Waste Management Conference in Richmond, Virginia on April 26, 1989. The purpose of the presentation and paper was to discuss the results of two cooperative agreements describing a non-traditional approach to pollution prevention based on research, technology transfer, and education; and to discuss current pollution prevention research progress of EPA's pollution prevention research program. The cooperative agreement with federal, state and trade association pollution prevention research approach emphasizes a non-regulatory means of encouraging industry to use innovative technologies and management practices that can both reduce pollution and provide economic benefits.

25869 (PB–90-148461/XAB) **CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) Compliance with Other Laws Manual: Part 2. Clean Air Act and other environmental tatutes and state requirements. Interim report (Final).** Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste and Emergency Response. Aug 1989. 176p. (EPA–540/G-89/009). Available from NTIS, PC A09/MF A01.

The purpose of the CERCLA Compliance with Other Laws Manual is to assist Remedial Project Managers (RPMs) in identifying and complying with all applicable or relevant and appropriate requirements (ARARs) for remedial actions taken at Superfund sites. This part of the guidance manual addresses CERCLA compliance with the Clean Air Act and other environmental statutes for remedial actions.

25870 (PB–90-148867/XAB) **Management of household and small-quantity-generator hazardous waste in the United States.** Duxbury, D. Energy and Environmental Research Corp., Durham, NC (USA). Dec 1989. 85p. Available from NTIS, PC A05/MF A01.

The International Solid Waste and Public Cleansing Association (ISWA), an international nongovernmental organization comprising twenty-seven national organizations of waste management professionals, conducted a survey to obtain information regarding household and small-quantity-generator hazardous wastes. The report presents the U.S. response to the survey. The questionnaire covered five different areas: (1) problems, (2) policy approach, (3) technical and organizational aspects, (4) case studies, and (5) treatment and disposal research and development. Comments were also invited. The appendices include the ISWA Questionnaire, a table and other information regarding State laws and regulations

governing household hazardous waste, and a listing of the permanent household hazardous waste collection programs operating in 1988.

25871 (PB–90-151788/XAB) **Environmental effects in the United States of DOD (Department of Defense) actions. Directive.** Ramsey, C. Assistant Secretary of Defense (Production and Logistics), Washington, DC (USA). 30 Jul 1990. 62p. (DOD-D–6050.1). Available from NTIS, PC A04/MF A01.

The Directive reissues DoD Directive 6050.1, March 19, 1974, implements the Council on Environmental Quality (CEQ) regulations, and provides policy and procedures to enable DoD officials to be informed of and take into account environmental considerations when considering the authorization or approval of major DoD actions in the United States. The Directive also cancels Report Control Symbol DD-H&E(Q)1326.

25872 (PB–90-151796/XAB) **Storage and disposal of non-DOD-owned hazardous or toxic materials on DOD (Department of Defense) installations. Directive.** Napolitano, S. Assistant Secretary of Defense (Production and Logistics), Washington, DC (USA). 27 Feb 1986. 5p. (DOD-D–6050.8). Available from NTIS, PC A01/MF A01.

The Directive cancels DoD Directive 6050.8, August 24, 1981, and establishes DoD policy, enunciated by Title 10, United States Code, Section 2692, Chapter 159, for the storage or disposal of non-DoD-owned toxic or hazardous materials on DoD installations.

2904 Energy Resources

Refer also to citation(s) 25402, 25633, 25862, 25863, 25864

25873 (AD-A–216250/1/XAB) **US strategic and critical materials imports: Dependency and vulnerability. The Latin American alternative. Final report.** Colombo, J.L. Naval War Coll., Newport, RI (USA). Center for Naval Warfare Studies. 31 May 1989. 52p. Available from NTIS, PC A04/MF A01.

In time of war or during a National Emergency, it will be necessary for the United States to minimize dependence on extra hemisphere supply. This paper examines the extent to which current suppliers of strategic and critical imported minerals and petroleum, received from outside the American Continent, could be superseded with Latin American sources, including the Caribbean, Central and South America. The paper concludes that this substitution of trade would be a desirable course of action now, to be pursued in peacetime, not only for the U.S. but also for the Latin American States as well. This paper lists the strategic and critical imported materials for the U.S., and also identifies current supply sources; determines to what extent current supply sources could be replaced by Latin American ones; identifies major U.S. policy changes that would be required to make new trade arrangements suitable, feasible, and acceptable; proposes conclusions, which are related to the future of the U.S. strategic stockpiling and to the improvement of the Latin American sources of supply.

25874 (BCMEMPR–90-01219) **British Columbia Ministry of Energy, Mines and Petroleum Resources annual report January-December 1987, January-March 31,1988.** British Columbia Ministry of Energy, Mines and Petroleum Resources, Victoria, BC (Canada). 31 Mar 1988. 33p. (MICROLOG–90-01219). Available from PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This annual report covers the 15-month period January 1, 1987-March 31, 1988, at which time the Ministry was reorganized. The report gives an overview of activities in the Energy Resources, Mineral Resources, and Revenue and Operational Services Divisions. Financial data is included. Highlights include deregulation of natural gas markets and prices and the development of a new market-based formula which reserves 15 years of proven natural gas supplies for the province's core market; a natural gas royalty holiday for new gas wells for 12-36 producing months; and the establishment of a simplified natural gas royalty system to take effect June 1, 1988. The Pacific Coast Energy Corp. proposal for a natural gas pipeline to Vancouver Island was selected. A new interruptible electricity heating rate was established to help reduce heating costs. 19 figs., 2 tabs.

25875 (CANWEC–CE02833, pp. 1-20) **Korea's energy experiences and implications for the future: Report 3.1.2.** Kim, H. (Seoul National Univ. (Republic of Korea)). Canadian National Committee, World Energy Conference, Ottawa, ON (Canada). 1989. (CONF-890901–: 14. world energy conference, Montreal (Canada), 17-22 Sep 1989; CE–02833). In *Energy for tomorrow. Division 3: Energy and the economy: Session 3.1: International aspects of energy economics.* Available from Canadian National Committee World Energy Conference, Suite 305, 130 Albert Street, Ottawa, ON, CAN K1P 5G4. Prices: $125.00 CAN.

The rapid growth of the economy and changes in its structure have accelerated the growth of energy demand, and caused significant changes in the pattern of the demand in the past two decades. This paper analyzes energy experience of Korea for the past two decades and overviews the energy future for the country. Implications were derived from the analyses to provide information and lessons to energy analysts and policy makers in late-coming developing countries. The information and lessons will be useful for those who are concerned with the global energy problems of the world. It is suggested that energy conservation in the developing countries by cooperative efforts between the developed and developing countries will be important not only for reducing the energy burden of the developing countries, but also for alleviating the global energy problems of the world in the future. 12 refs., 7 tabs.

25876 (CANWEC–CE02833, pp. 1-37) **Assessing ASEAN's [Association of Southeast Asian Nations] energy policies in the 1990s: Report 3.1.1.** Fee, W.L. (Agriculture Univ. of Malaysia (Malaysia)). Canadian National Committee, World Energy Conference, Ottawa, ON (Canada). 1989. (CONF-890901–: 14. world energy conference, Montreal (Canada), 17-22 Sep 1989; CE–02833). In *Energy for tomorrow. Division 3: Energy and the economy: Session 3.1: International aspects of energy economics.* Available from Canadian National Committee World Energy Conference, Suite 305, 130 Albert Street, Ottawa, ON, CAN K1P 5G4. Prices: $125.00 CAN.

Although the ASEAN region as a whole is self-sufficient in energy, the region is doubly dependent on energy both as a major source of revenue and as fuel to the growing industrial, manufacturing, transport, and residential sectors. The region's moderate level of energy reserves, its unequal geographical distribution, and the lack of basic planning. A parallel development in the energy scene is the recent interest in the development of natural gas and coal investment. The main considerations are the high costs of investment, the long gestation period (10-20 years) in energy exploration, and the necessary infrastructres for the expansion of gas and electricity. This paper assesses the impact of economic growth on ASEAN energy policies and strategies in the 1990's. Part 1 a broad survey of ASEAN energy reserve estimates, supply potential, and the pattern of energy demand by and uses. Part 2 analyzes the changing economic structure within the region and its effets on the future demand for enrgy. Part 3 analyzes ASEAN energy outlook. 26 refs., 1 figs., 17 tabs.

25877 (PB–90-146366/XAB) **Analysis of the minerals situation in the United States: 1989-2040. Forest Service general technical report (Final).** Forest Service, Fort Collins, CO (USA). Rocky Mountain Forest and Range Experiment Station. Sep 1989. 47p. (FSGTR-RM–179). Available from NTIS, PC A03/MF A01.

The report analyses the trends in consumption of minerals and projected demand; the nation's minerals resources; the minerals supply situation; how supply compares to expected demands; social, economic, and environmental implications of the supply/demand comparisons; opportunities for meeting the nation's minerals needs; and constraints to identified opportunities; implications for renewable resource programs.

25878 (PB–90-159260/XAB) **Efficient management of multiple water sources given a range of quality levels and user quality requirements. Final report.** Lieuwen, A.L.; Colby, B.G.; Davis, D.R.; Martin, W. Arizona Univ., Tucson, AZ (USA). Dept. of

Agricultural Economics. Dec 1989. 134p. Available from NTIS, PC A07/MF A01.

The research project consists of an institutional and economic assessment of effluent reuse in Arizona's Tucson Basin. The study area characterizes much of the urbanizing West in terms of limited and increasingly expensive water supplies, concerns with water quality, and the desire to develop reliable supplies to support a growing population. The Arizona case study is particularly interesting in light of a legislative mandate to reduce groundwater pumping and eliminate groundwater overdraft. Effluent reuse is perceived as a key strategy in achieving these policy objectives. The economic assessment compares potential benefits and costs of implementing water reuse plans for the Tucson area with potential benefits and costs of alternative water-supply scenarios in which similar quantities of water are provided from other sources. Alternative water sources include pumping native groundwater, (reallocating) water away from low value water uses, and importing surface water and groundwater from other basins. The economic analysis indicates that, at the present time, there is no economic justification for increased water reuse. Not only are reallocation and importation alternatives less costly to implement than increases in effluent use, they also save more groundwater and thus go further in achieving state policy objectives.

2905 Research, Development, Demonstration, and Commercialization

Refer also to citation(s) 25477, 25676, 25689, 25840, 25867, 25874, 25910, 25914, 25984, 26031, 26439, 27342

25879 (DOE/EIA–0035(89/12)) **Monthy energy review, December 1989.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. 27 Mar 1990. 145p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE90009256. Available from NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.

This article traces key financial trends in the US energy industry as a whole and in several of the industry's major segments for the fourth quarter 1989 and year 1989. Financial data for companies are included for two broad groups–fossil fuel producers and rate-regulated utilities. Data were taken from published information provided by publicly traded companies. Sources include The Wall Street Journal, corporate reports, and energy trade publications.

25880 (DOE/EIA–0484(90)) **International energy outlook 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. 20 Mar 1990. 56p. Sponsored by U.S. DOE Management & Administration. Order Number DE90009069. Available from NTIS, PC A04/MF A01 - GPO - OSTI; GPO Dep.

This report presents the current Energy Information Administration (EIA) assessment of the long-term outlook for international energy markets. This report is provided, as are other EIA reports, as a statistical service for use by managers and international energy analysts and not as a government energy plan. Current United States Government policies and foreign government policies are assumed to hold over the projection interval, which extends to the year 2010. This report emphasizes oil market developments, particularly future world oil prices and oil production potential. This emphasis in no way minimizes the importance of other energy markets; moreover, the analysis recognizes that the development of alternative energy sources impacts directly on the world oil market. The world oil price projections developed in this international setting are, in turn, used as assumptions for analyses of The United States domestic energy market provided in EIA's Annual Energy Outlook 1990. Since the United States energy market affects and is affected by the international market, the methodology incorporates this interaction to the extent possible. The domestic energy projections shown in this report are the same as those contained in the Annual Energy Outlook 1990. Projections in this report are also consistent with those published in EIA's October 1989 Short-Term Energy Outlook. Sources providing more detailed discussions on the United States domestic markets and other subjects discussed in this report are referenced in Appendix D. 31 figs., 14 tabs.

25881 (DOE/OR/21400–T415) **ORNL and the University Of Tennessee: A partnership for the future.** Trivelpiece, A.W. Oak Ridge National Lab., TN (USA). 15 Sep 1989. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008864. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper discusses the past and the future of Oak Ridge National Laboratories and its many contributions. (FSD)

25882 (FRNC-TH–3571) **Development and technology choices: the energy conservation case in the tunisian industry.** Sellami, H. Ecole Centrale des Arts et Manufactures, 92 - Chatenay-Malabry (France). 1988. 304p. (In French). Order Number DE90770646. Available from NTIS (US Sales Only), PC A14/MF A01.

In this study, the problem of the technological choices in the developing countries is examined through a field survey of the energy conservation possibilities in the tunisian industry. The comparison of the situation in France and in Tunisia concerning the energy performance and efficiency showed that the debate between the appropriate technologies and the technological short-cut could be overpassed and summarized by the technological relative short-cut concept, as the tunisian industrial processes are, in general, not very sophisticated.

25883 (NRC/E–26612) **Alternative energy technology in Canada: NRC's Energy R&D Program 1975-1985.** National Research Council of Canada, Ottawa, ON (Canada). Div. of Energy. Sep 1986. 164p. (CE–02981). Available from National Research Council of Canada, Publication Sales and Distribution Office, Montreal Road, Ottawa, ON, CAN K1A 0R6. Prices: PRICES UPON REQUEST.

This report focuses on the status of alternative energy technology and, more specifically, it deals with the portion of the federal government of Canada's program of energy research and development that was coordinated by the National Research Council (NRC)'s Division of Energy. This program encompassed activities in solar energy wind energy, bioenergy, peat, residential and industrial heat pumps, hydrogen and energy storage systems, and nuclear fusion. Though a small part of the research was done in NRC's laboratories, most of it was conducted, under NRC's supervision, by industrial organizations, university researchers, engineering companies, consultants, and a variety of other institutions, same of this work being done by international cooperation. For each energy source, the report gives the rationale and background of the program, outlines international development, describes the status of the technology in Canada (research, demonstration plants and design methods), discusses the economic prospects for this form of energy, and, in same cases, gives recommendations as to the pursuance of the program. Some data are also provided on research and development funding and on energy supply and demand in Canada. 44 refs., 57 figs., 6 tabs.

25884 (Y/DX–916) **Advanced Manufacturing Technology: A Department of Energy technology transfer initiative.** Steele, R.S. Jr.; Barkman, W.E. Oak Ridge Y-12 Plant, TN (USA). 1 Feb 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OS21400. (CONF-9005134–1: 2. International conference on computer integrated manufacturing, Troy, NY (USA), 21-23 May 1990). Order Number DE90008601. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper describes a new initiative called the Advanced Manufacturing Technology (AMT) Program that is managed for the US Department of Energy (DOE) by Martin Marietta Energy Systems in Oak Ridge, Tennessee. The AMT Program seeks to assist the US manufacturing community regain some of the market share that it has lost to competiting companies in both Europe and the Far East. One key element to this program is the establishment of teaching and development facilities called manufacturing technology centers (MTCs) which will showcase unclassified DOE manufacturing technologies. This paper describes some of the precision flexible manufacturing system (PFMS) technology that is available through the Oak Ridge Y-12 Plant. This technology will be highlighted in the first of the MTCs that is being established. 4 figs.

2906 Nuclear Energy

Refer also to citation(s) 25569, 25751, 25783, 25784, 25909, 26751, 27146, 27147, 27148, 27149, 27150, 27151, 27152, 27153, 27154, 27155, 27156, 27157, 27158, 27342

25885 (DOE/IG–0279) **Administrative facility requirements at the Savannah River Site.** . USDOE Office of Inspector General, Oak Ridge, TN (USA). Eastern Regional Office. 13 Mar 1990. 14p. Sponsored by U.S. DOE Office of Inspector General. Available from OSTI.

Report to The Secretary.

Attached is a copy of our audit report on Administrative Facility Requirements at the Savannah River Site. The report includes the findings and recommendations that were presented in our Flash Report ER-F-90-1, "Administrative Facility Requirements at the Savannah River Site," issued October 19, 1989. The objective of the audit was to determine if the Department of Energy was using the most economical method to satisfy Savannah River Operations Office's (SRO) long term administrative space requirements. Significant expenditures were planned at the Savannah River Site (SRS) to provide additional administrative facilities (office space). Our audit showed that over a 25-year period the Department could save more than a quarter billion dollars by: (1) constructing administrative facilities onsite, (2) canceling plans to lease offsite office space, (3) rescinding approval to purchase 120 trailers, and (4) canceling planned General Plant Projects (GPP) that are not cost effective or efficient. The critical path to achieving these savings is to determine projected office space requirements and obtain the funds to begin construction immediately.

25886 (LBL-PUB–625-App.) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Press clippings: Appendix.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Dec 1989. 410p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

This book contains a very limited sampling of press clippings from my tenure as Chaiman of the Atomic Energy Commission (1961–1971). A more complete collection of these has been deposited with the Manuscript Division of the Library of Congress. This serves as an appendix to the Journal of Glenn T. Seaborg, Chairman of the Atomic Energy Commission, 1961–1971, which has been printed by the Lawrence Berkeley Laboratory in 25 volumes. Copies of this 25-volume daily journal have been deposited at the Lawrence Berkeley Laboratory, the Bancroft Library of the University of California at Berkeley, the University of California at Los Angeles Main Library, the University of California at Santa Barbara, the National Archives, the Library of Congress, and the presidential libraries of Kennedy, Johnson and Nixon.

25887 (LBL-PUB–625-Vol.3) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 3, January 1, 1962–June 30, 1962.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 675p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include an historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Vol. 3 which covers the first 6 months of 1962.

25888 (LBL-PUB–625-Vol.4) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 4, July 1, 1962–December 31, 1962.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 642p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 4 which covers July 1962 thru December 1962.

25889 (LBL-PUB–625-Vol.5) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 5, January 1, 1963–June 30, 1963.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 687p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include an historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subjects areas over the ten-year period. This is Volume 5 which covers the first 6 months of 1965.

25890 (LBL-PUB–625-Vol.6) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 6, July 1, 1963–November 22, 1963.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 548p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 6 which covers July–November 1963.

25891 (LBL-PUB–625-Vol.7) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 7, November 23, 1963–February 28, 1964.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 531p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of selected number of subject areas over the ten-year period. This is Volume 7 which covers November 1963 thru February 1964.

25892 (LBL-PUB–625-Vol.8) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 8, March 1, 1964–June 30, 1964.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 610p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 8 which covers March thru June 1964.

25893 (LBL-PUB–625-Vol.9) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 9, July 1, 1964–December 31, 1964.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 580p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 9 which covers July thru December 1964.

25894 (LBL-PUB–625-Vol.10) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 10, January 1, 1965–June 30, 1965.** Seaborg, G.T.

Lawrence Berkeley Lab., CA (USA). c Jan 1989. 697p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 10 which covers January thru June 1965.

25895 (LBL-PUB–625-Vol.11) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 11, July 1, 1965–December 31, 1965.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 788p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 11 which covers July thru December 1965.

25896 (LBL-PUB–625-Vol.12) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 12, January 1, 1966–June 30, 1966.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 694p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 12 which covers January thru June 1966.

25897 (LBL-PUB–625-Vol.13) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 13, July 1, 1966–December 31, 1966.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 707p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of selected number of subject areas over the ten-year period. This is Volume 13 which covers July thru December 1966.

25898 (LBL-PUB–625-Vol.14) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 14, January 1, 1967–June 30, 1967.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 835p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 14 which covers January thru June 1967.

25899 (LBL-PUB–625-Vol.15) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 15, July 1, 1967–December 31, 1967.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 664p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 15 which covers July thru December 1967.

25900 (LBL-PUB–625-Vol.20) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 20, September 1, 1969–December 31, 1969.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 768p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 20 which covers September thru December 1969.

25901 (PB–90-162751/XAB) **Department of Defense policy on furnishing information to the Joint Committee on Atomic Energy. Instruction.** Reid, J. Assistant Secretary of Defense (Atomic Energy), Washington, DC (USA). 26 Jul 1960. 6p. (DOD-I–5030.16). Available from NTIS, PC A02/MF A01.

The Instruction implements Section III, paragraph 6, of the Department of Defense (DoD) Directive 5148.2, by describing the policy and establishing the procedures for transmission of Department of Defense Information to the Joint Committee on Atomic Energy. DoD Instruction 5148.3, December 28, 1954, is hereby superseded and canceled.

2910 Conservation

Refer also to citation(s) 26012

25902 (AFME-Z–0095-Vol.2) **Energy conservation, AFME-BECC workshop volume 2.** Cremieux, M.; Thomas, J.J.; Terminet Schuppon, B. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1986. 70p. (In French). Order Number DE90770659. Available from NTIS (US Sales Only), PC A04/MF A01.

The chinese french cooperation conference concerning energy conservation was composed of three main themes: rational use of energy in industry (variable speed motors, heat recovery on diesel boilers and gaz turbines, industrial heat network, electric infra-red heating in textile industry), energy conservation in the transportation sector (fuel consumption meter, energy consumption diminution in transport vehicles), local production of energy through methanic fermentation, use of coal and up-grading of municipal wastes in heat networks, geothermal production of heat, thermally insulated ductile cast iron ducts for heat networks and district heating, geothermal district heating.

2920 Supply, Demand, and Forecasting

Refer also to citation(s) 25865, 25875, 25876, 25911, 25921

25903 (CANWEC–CE02833, pp. 1-20) **Economic and structural influences defining the role of petroleum in the global energy future: Report 3.1.5.** Leigh, J.M. (BHP Petroleum (Australia)); Ashby, A.B.; Dereyfus, D.A. Canadian National Committee, World Energy Conference, Ottawa, ON (Canada). 1989. (CONF-890901–: 14. world energy conference, Montreal (Canada), 17-22 Sep 1989; CE–02833). In *Energy for tomorrow. Division 3: Energy and the economy: Session 3.1: International aspects of energy economics.* Available from Canadian National Committee World Energy Conference, Suite 305, 130 Albert Street, Ottawa, ON, CAN K1P 5G4. Prices: $125.00 CAN.

Projections of world oil supply, demand, and price are most commonly based upon the historical experience with relationships between supply and demand behavior and price changes. The future requirements for petroleum are often projected in terms of historical uses and price elasticties. Supply reactions are predicted

using assumed revenue optimization strategies of the exporting nations based upon observed past behavior. An alternative approach to evaluating the future role of petroleum considers the requirements for energy services by the energy comsuming sector (i.e., transportation, industry, electric utilities, residential and commercial). The future requirement for energy in each sector can be projected based upon historical use patterns and upon estimates of future trends in GDP, population, industrial growth or restructuring, energy intensity, and urbanization. Energy requirements can then be allocated amoung the alternative energy sources by considering the combined fuel and capital expenses of providing the energy service and the availabilty of indigenous resources. This paper compares and contrasts the two approaches in terms of the factors that are included in and omitted from each. It also draws conclusions about the validity of each approach and the possibility of synthesizing a consensus forecast. Despite the differing approaches, the results are in remarkable agreement with one another when they are based upon similar future circumstances. A more significant conclusion of the comparison is both methodologies could benefit from an examination of the comparative results and, in light of the conclusions, minor modifications to the approaches being used. 3 refs., 4 figs., 3 tabs.

25904 (PB–90-142225/XAB) **Data base for use in R and D appraisal and price-quantity forecasting at the Gas Research Institute. Annual report, September 1982-June 1983.** Haas, S.M.; Marshalla, R.A.; Nesbitt, D.M.; Oman, D.B. Decision Focus, Inc., Los Altos, CA (USA). 1983. 235p. Available from NTIS, PC A11/MF A02.

See also report No. 5, PB–88-183009 and PB–90-142226.

Cost, performance, resource and economic data are presented which will be used as input to the Decision Focus Inc. (DFI) interfuel and intertechnology model used to compute supply-demand scenarios in support of the GRI budget and project area planning. The data base includes estimates for all existing and future gas and non-gas technologies, fuels and policy variables considered important to GRI long-range planning.

2930 Policy, Legislation, and Regulation

Refer also to citation(s) 25755, 25756, 25757, 25758, 25759, 25760, 25761, 25762, 25763, 25764, 25765, 25766, 25767, 25768, 25769, 25923, 25928, 26657, 26658, 26659, 26660, 26661, 26662, 26663, 26664, 26665, 26666, 26667, 26668, 26669, 26670, 26671, 26672, 26673, 26674, 26675, 26676, 26677, 26678, 26679, 26680, 26681, 26682, 26683, 26684, 26685, 26686, 26687, 26688, 26689, 26690, 26691, 26692, 26693, 26694, 26695, 26696, 26697, 26698, 26699, 26700, 26701, 26702, 26703, 26704, 26705, 26706, 26707, 26708, 26709, 26710, 26711, 26712, 26713, 26714, 26715, 26716, 26717, 26718, 26719, 26720, 26721, 26722, 26723, 26724, 26725, 26726, 26727, 26728, 26729, 26730, 26731, 26732, 26733, 26734, 26735, 26736, 26737, 26738, 26739, 26740, 26741, 26742, 26743, 26744, 26745, 26746, 26747, 26748, 26749, 26750, 26751, 26752, 26753, 26754, 26755, 26756, 26757, 26758, 26759, 26962

25905 (BC/CW–89-05844) **Report of the Coquitlam Watershed pipeline inquiry.** MacKay, D.L. British Columbia, Province of, Vancouver, BC (Canada). Jul 1989. 124p. (MICROLOG–89-05844). Available from PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

An inquiry was held to review all the technical matters relating to the routing of the considered natural gas pipeline, the availability of alternatives, and the identification and management of water quality and environmental impacts. The inquiry's methods and findings in these matters are discussed in detail. The submissions received from a wide range of groups and associations, from the municipalities in the pipeline service area, and from individuals, are summarized. The main preoccupations expressed were water quality and the intergrity of the watershed, the balance to be stuck between acceptance of risk and foregoing the benefits of providing natural gas to the Vancouver Island service area, pipeline safety and the concern over potential pipline leaks, fire hazards and contamination, and, finally the fear of setting a precedent for the incussion of other uses in watershed areas. The report discusses the selection of the watershed route and the alternative routes, the point of view of the Greater Vancouver Water District (GVWD) and that of the Greater Victoria Water District, watershed management activities, environment, land use and cost considerations, and water quality preservation measures. In his statement of principle, the Commissioner contends that a workable agreement and careful joint planning of construction and operations are necessary. The Vancouver Island natural gas pipeline is allowed through the Coquitlam Watershed; the other aspects of the decision deal with water quality, with the safety of the water system during construction time, with the relations between the GVWD and the Pacific Coast Energy Corporation (PCEC), with the timing of the construction of the pipeline, and with the arbitration of future disputes. 18 figs., 14 tabs.

25906 (BCUC–90-00672) **British Columbia Utilities Commission, 1988 annual report.** British Columbia Utilities Commission, BC (Canada). [1989]. 94p. (MICROLOG–90-00672). Available from PC British Columbia Utilities Commission, 800 Smithe St., 4th Floor, Victoria, B.C., CAN V6Z 2E1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The British Columbia Utilities Commission is a regulatory agency of the provincial government whose primary responsibility is the regulation of the energy utilities under its jurisdiction. The Commission also has responsibility in the review and evaluation of energy related projects designated as subject to Part 2 of the Utilities Commission Act. The Commission's review and evaluation involves public hearings, and Commission staff may assess applications, submissions and complaints made to the Commission. Applications are principally concerned with matters relating to revenue requirements, rate design, facilities expansion, and financing. The Commission's regulatory responsibility includes electric, gas, steam, and telecommunications utilities. This report provides a review of Commission activities, including summaries of hearings and decisions, sales statistics, and a directory of utilities regulated by the Commission. In 1988, the Commission was affected procedurally by the accelerated move to competitive energy markets. Changes were adopted to the Commission's internal procedures to respond to changing policies and market developments. Legislative changes were instituted which required the Commission to review the gas supply arrangements of utilities and direct sale companies. In addition, the Commission became self-funding on April 1, 1988. Amendments to the Utilities Commission Act were passed in 1988 requiring energy supply contracts to be filed with the Commission, as well as setting up a framework for promotion of partial deregulation of the electricity generation industry. 10 figs., 4 tabs.

25907 (DOE/DP/48058–1-Rev.) **Research and development of methods and tools for achieving and maintaining consensus processes in the face of change within and among government oversight agencies: Technical progress report, October 1, 1988–May 29, 1989: Revised.** Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (USA). Management Systems Labs. Dec 1989. 30p. Sponsored by U.S. DOE Defense Programs. DOE Contract FG02-88DP48058. Order Number DE90008984. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report presents progress and results of our research in participative, consensus-based decision processes in six areas: theory and concept; test sites; frameworks and models; consensus methods; consensus tools;and consensus process. We focused on the last two in our year one research. We've established preliminary definition and measurement techniques for several types of consensus and related activities. We've also conducted a multidisciplinary literature search of 280 data bases which will lead to frameworks and models in year two. In consensus process studies, we've researched factors required to gain consensus, and we've developed a framework. We're using DOE'S Waste Management Review Group to model inter-group consensus among public interest groups. (MSL facilitated their first meeting.) Another test site, or consensus group, we're observing is DOE's States Review Group,

which consists of representatives from States and tribal governments. They're evaluating the drafts and final version of DOE's Environmental Restoration and Waste Management Five Year Plan. MSL also participated on the Five Year Plan Task Force and helped address the issues people need to come to consensus over. In researching consensus tools available to DOE, MSL visited ten sites and documented over 100 information systems DOE managers use to characterize and track waste and to make waste and environmental decisions. In another information systems study, MSL assessed RADTRAN'S capabilities to present the appropriate information to the States, Tribes, and DOE for reaching consensus on risks associated with shipping radioactive waste. 5 figs.

25908 (DOE/OR/21400–T416) **Fiscal year 1991 basic energy science budget: Testimony before the Subcommittee on Energy Research and Development, Committee on Science, Space, and Technology.** Hayter, J.B. Oak Ridge National Lab., TN (USA). 20 Mar 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009241. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This document contains testimony to a congressional subcommittee concerning the budget for the Advanced Neutron Source for FY 1991. (FSD)

25909 (DOE/RW–0216) **Office of Civilian Radioactive Waste Management annual report to Congress.** USDOE Office of Civilian Radioactive Waste Management, Washington, DC (USA). Dec 1989. 51p. Sponsored by U.S. DOE Radioactive Waste Management. Available from OSTI; INIS.

This sixth Annual Report to Congress by the Office of Civilian Radioactive Waste Management (OCRWM) describes activities and expenditures of the Office during fiscal year 1988. An epilogue chapter reports significant events from the end of the fiscal year on September 30, 1988 through March 1989. The Nuclear Waste Policy Amendments Act (NWPA) of 1987 made significant changes to the NWPA relating to repository siting and monitored retrievable storage and added new provisions for the establishment of several institutional entities with which OCRWM will interact. Therefore, a dominant theme throughout this report is the implementation of the policy focus and specific provisions of the Amendments Act. 50 refs., 8 figs., 4 tabs.

25910 (ENEA-RT-PICO–89-03) **Evaluation of investment in R&D and industrial promotion programs: Selectioninig criteria for interventions and determination of ENEA's participation.** Cesarano, P. ENEA, Rome (Italy). Oct 1989. 97p. (In Italian). (RT/PICO–89-3). Order Number DE90764318. Available from NTIS (US Sales Only), PC A05.

With reference to the development, promotion and use of innovative energy technologies within Italian industry by ENEA (Italian Commission for Alternative Energy Sources),the purpose of this report is to convey an understanding of how investment projects and their associated risks are linked and to describe an effective methodology to assure the profitability of investment projects through benefit-cost analysis. It attempts to provide a basic understanding of the theoretical foundations of benefit-cost analysis and, perhaps more importantly, it seeks to demonstrate the application of benefit-cost analysis in a realistic situation, for example, of evaluation of private projects. Finally, some criteria are presented for the selection of investment projects, ENEA's public contribution-sharing involvment in private sector programs or projects is defined relative to the guidelines set forth in the National Energy Plan.

2940 Fossil Fuels

Refer also to citation(s) 25294, 25295, 25312, 25333, 25341, 25343, 25356, 25383, 25384, 25385, 25392, 25431, 25435, 25465, 25466, 25467, 25469, 25470, 25471, 25477, 25504, 25750, 25879, 25903, 25904, 25906, 25922

25911 (CERI–89-05379, pp. 27-46) **A global view of gas reserves and markets.** Itteilag, R.L. Canadian Energy Research Inst., Calgary, AB (Canada). 1986. (CONF-8609481–: International oil and gas markets conference, Calgary (Canada), 15-16 Sep 1986; MICROLOG–89-05379). In *Papers presented at the International oil and gas markets conference.* Available from PC Canadian Energy Research Institute, 3512-33rd St. NW, Calgary, AB, CAN T2L 2A6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $100.00 CAN; MF $10 CAN.

The USA has 160-170 trillion cubic feet (TCF) of proven natural gas reserves plus another 650 TCF of potential reserves. The current excess production capability will dissipate by 1990 because of higher demand, reduced drilling activity and stability of imports from Canada. Unused production capacity reached a peak in 1983 and then began to decline as a result of reduced drilling activity. A decline in production per gas well is expected to bring production levels to 17,303 billion cubic feet in 1990. The USA has lost its dominant place as a producer of natural gas since the 1970s. European, USSR and Asian natural gas usage has increased by 180%. World gas production has increased at a rate of 2.7%/y from 1975 to 1984. By 1984 the USSR produced 36% of the world's natural gas. Total gas demand is growing rapidly and is expected to reach 19.2 TCF in 2000. Natural gas will increasingly replace electricity in commercial cooling operations, it will find increasing use in cogeneration of electricity, in combined cycle power plants, and as a vehicular fuel. 3 figs., 10 tabs.

25912 (MPUB–2/90) **Greater Winnipeg Gas Company and ICG Utilities (Manitoba) Ltd. - Application for an interim order approving a change in sales rates on an interim refundable basis for all gas consumed on and after January 1, 1990.** Manitoba Public Utilities Board, Winnipeg, MB (Canada). 3 Jan 1990. 52p. (CE–02980). Available from Manitoba Public Utilities Board, 280 Smith Street, 2nd Floor, Winnipeg, MB, CAN R3C 1K2. Prices: PRICES UPON REQUEST.

This Board hearing was held to consider an application by Greater Winnipeg Gas Co. and ICG Utilities (Manitoba) Ltd. for approval of interim refundable rates effective January 1, 1990 to enable the Companies to recover a revenue deficiency and earn a higher overall rate of return than that approved earlier. Approval would add an increase of up to 7.18% on residential gas heating bills and up to 2.73% on small commercial heating bills annually. The Companies applied for a rate determination using 9 months actual and 3 months forecast data, rather than the usual year-end audited results. This document gives background information, and discusses the application, the rate base, mid-year plant, financial information, taxation, gas costs and revenues, revenue requirement, and cost allocation/rate design. In addition, the Board expressed its concerns with the current regulatory process and the frequency of hearings. The Board used a mid-year rate base for rate setting purposes, adjusted the Companies' revenue requirements to a lower figure, and approved the Companies' rate design, although it did not approve the request to standardize the fixed monthly charge between rate divisions. The charge to residential heating consumers increased up to 4.44% annually and the impact on small commercial consumers remained unchanged.

25913 (SCBCS–90-01592) **Barber commission on SaskEnergy: Final report.** Saskatchewan Barber Commission on SaskEnergy, Regina, SK (Canada). Nov 1989. 213p. (MICROLOG–90-01592). Available from PC Saskatchewan Power Corporation, 2025 Victoria Ave., Regina, SK, CAN S4P 0S1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

In the spring of 1989, the Government of Saskatchewan initiated a proposal to transfer to the private sector equity ownership in SaskEnergy, the Crown-owned natural gas utility. The Comission on SaskEnergy Public Participation was established to review the enabling legislation and report upon its probable effects in certain designated areas, including control of the utility, impact upon rates, both gas and electrical, and such economic benefits as might flow from the proposed privatization. The Commission concluded that the proposed privatization of SaskEnergy should be examined in the light of the current debt level of SaskPower and the impact of the proposed share offering on the debt of SaskPower and its guarantor, the Government of Saskatchewan; and the potential for diversification of the company itself, and the resulting potential

benefits to the provincial economy. The proposal has the potential to accomplish both a significant reduction in SaskPower's debt and to contribute to diversification of the company itself and the provincial economy. 2 figs., 11 tabs.

25914 (SOQUIP–90-01060) **SOQUIP: Annual report, 1988-1989.** . SOQUIP, Quebec, PQ (Canada). [1989]. 25p. (MICROLOG–90-01060). Available from PC SOQUIP (Societe quebecoise d'initiatives petrolieres), 1175, rue de Lavigerie, C.P. 10650, Ste-Foy, PQ, CAN G1V 4P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

SOQUIP is a Quebec government corporation whose activities include exploration and production of hydrocarbons, natural gas distribution, design and development of energy related projects, and consulting services. This report reviews the activities over the year of SOQUIP and its subsidiaries, including SOQUIP Alberta, SOQUIP Gaz, SOQUIP Atlantique, the Soligaz Project, and Noverco. Highlights of the year include the acquisition by Sceptre Resources (indirectly owned by SOQUIP via SOQUIP Alberta and Noverco) of Oakwood Petroleums, making Sceptre the eighth largest non-integrate petroleum company in Canada; renewal of the gas sales contracts between SOQUIP Gaz and Gaz Metropolitain; acquisition by SOQUIP of the assets of Nova Pressure Transport, making SOQUIP the only Canadian company transporting natural gas by semi-trailer; and renewal of a consulting agreement in Morocco with Petro-Canada. Production and consumption information, and financial statements, are also included.

2960 Electric Power

Refer also to citation(s) 25632, 25658, 25680, 25693, 25727, 25735, 25743, 25744, 25745, 25746, 25747, 25751, 25834, 25839, 25841, 25879, 25906, 25954

25915 (AEEMA–90-00547) **Alberta Electric Energy Marketing Agency annual report, 1988-89.** Alberta Electric Energy Marketing Agency, Edmonton, AB (Canada). [1989]. 18p. (MICROLOG–90-00547). Available from PC Alberta Electric Energy Marketing Agency, Woodward Tower, Ste. 711, 400 Fourth Ave., Lethbridge, AB, CAN T1J 4E1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

An annual report is given of the administrative agency established in 1982 by the Alberta government to manage the purchasing and selling of the electricity produced by the province's 3 large franchised generators of electricity Alberta Power Ltd., the City of Edmonton (Edmonton Power), and TransAlta Utilities Corp.. The Agency also administers a price shielding program scheduled to run to December 31, 1990. The report includes an overview of agency operations, and descriptions of the mandate, the pooling process, and the shielding of low-cost power producers. A financial statement is included. 5 figs., 10 tabs.

25916 (APUB–E3.3.6.3/90) **Decision E89097 re: TransAlta Utilities Corporation, Alberta Power Limited and Edmonton Power in the matter of the price for which Alberta Power Limited, Edmonton Power and TransAlta Utilities Corporation shall sell electric energy to the Alberta Electric Energy Marketing Agency in 1990 pursuant to the Electric Energy Marketing Act.** . Alberta Public Utilities Board, Edmonton, AB (Canada). 15 Dec 1989. 101p. (CE–02908). Available from Public Utilities Board for the Province of Alberta, 10055-106th St., 11th Floor, Edmonton, AB, CAN T5J 2Y2. Prices: PRICES UPON REQUEST.

The Board received filings dated June 1, 1989 in which each of Alberta Power Ltd. (APL), Edmonton Power (EP), and TransAlta Utilities Corp. (TransAlta) filed forecasts of costs in support of prices to be set for each consumer group at which electric energy is to be sold to the Electric Energy Marketing Agency (EEMA) for the year 1990. Public hearings were held in October 1989. The Board in this Decision has determined the basis for the price at which the 3 Utilities will sell electric energy to EEMA during 1990. Issues addressed include total utility costs; functionalization upstream/downstream; classification/allocation to demand energy and voltage levels; treatment of interruptible and peak shaving loads for allocation of generation and transmission plant costs; and hearing costs reserve. The Board decided that cost recovery associated with Genesee Unit 2 Generating Station should commence in 1990; that the expenditures incurred by EP in purchase of land for the Genesee project should not all be included in the 1990 rate base; and that the rate of return on common equity for all 3 utilities be 13.5% for 1990. 10 tabs.

25917 (APUB–E3.5.89-62) **Decision E89095 re: Alberta Power Limited in the matter of a General Rate Application by Alberta power Limited for approval of new rates, charges or schedules for electric light power or energy furnisheed to its customers in Alberta for the 1989 and 1990 test years.** Alberta Public Utilities Board, Edmonton, AB (Canada). 15 Dec 1989. 144p. (CE–02906). Available from Public Utilities Board for the Province of Alberta, 10055-106th St., 11th Floor, Edmonton, AB, CAN T5J 2Y2. Prices: PRICES UPON REQUEST.

Alberta Power Ltd. filed an application on June 1, 1989 for approval to change existing rates, charges or schedules for electric light, power or energy for the test years 1989 and 1990. The Board held public hearings in September 1989. This Decision determined APL's rate base and revenue requirement for each of the test years and addressed the questions of the costs of Sheerness 2 Generating Station, the SPC-DC tie, fair return, reserve for injuries and damages, forecast sales and revenues, and revenue deficiency/surplus. The Board decided that the completed costs of Sheerness 2 be held for future use and be allowed to earn a reduced non-cash return on the plant consistent with the principle of risk sharing when a generating unit is completed prior to need; that the SPC-DC tie should be excluded from the 1989 and 1990 rate base; that the composite rate of return on the rate base should be 10.4% for 1989 and 1990; an amount required to re-establish the reserve fund for injuries and damages; adjusted sales upward for 1990 by 1%; and determined a revenue deficiency in 1989 but no revenue deficiency in 1990. This document presents the arguments of the major intervenors as well as that of the applicant. 23 tabs.

25918 (APUB–E3.6.5/88) **Decision E89096 re: Alberta Power Limited, Edmonton Power and Transalta Utilities Corporation in the matter of a joint application for the Board to adjust the prices or pricing formula in respect of each consumer group at which electric energy was sold to the Electric Energy Marketing Agency in 1988.** Alberta Public Utilities Board, Edmonton, AB (Canada). 15 Dec 1989. 29p. (CE–02907). Available from Public Utilities Board for the Province of Alberta, 10055-106th St., 11th Floor, Edmonton, AB, CAN T5J 2Y2. Prices: PRICES UPON REQUEST.

On May 1, 1989, Alberta Power Ltd., Edmonton Power and TransAlta Utilities Corp. filed a joint application for an order adjusting the forecast prices to the Agency in respect of each consumer group set by the Board for 1988. Filings by intervenors were conducted by written submissions. This document summarizes the arguments of each, covering total utility costs in general and for each utility; functionalization upstream/downstream; classification/allocation of upstream costs to demand, energy and voltage levels; and allocation to consumer groups. This Board decision covers various items to be included in filings by all three utilities and by each individual utility.

25919 (APUB–E3.6.89-21) **Decision E89091 re: TransAlta Utilities Corporation in the matter of a Filing by TransAlta Utilities Corporation, pursuant to a direction of the Public Utilities Boad in Order C88027 dated November 14, 1988, for an Order or Orders fixing new rates, charges or schedules thereof for electric light, power or energy furnished by TransAlta Utilities Corporation to and for the public in Alberta during the years 1988, 1989 and 1990.** Alberta Public Utilities Board, Edmonton, AB (Canada). 15 Dec 1989. 330p. (CE–02909). Available from Public Utilities Board for the Province of Alberta, 10055-106th St., 11th Floor, Edmonton, AB, CAN T5J 2Y2. Prices: PRICES UPON REQUEST.

In November 1988 the Board directed TransAlta Utilities Corp. (TransAlta) to file information which would enable the Board to fix just and reasonable rates for the 1988, 1989, and 1990 test years. Public hearings relating to Phase I were held in August/September

1989. The Board in this Decision has determined TransAlta's rate base and revenue requirement for each of the test years. This document covers arguments on rate base, fair return on rate base, electric utility revenue requirement, the treatment of Electric Energy Marketing Agency transfer payments, modelling of the Alberta interconnected system, utility vs. non-utility operations, contract tendering procedures, and electric utility revenues. The Board decided that the completed costs of Sheerness Unit 2 Generating Station be held for future use; that the portion of the Keephills-Ellerslie system costs applicable to Edmonton Power be included in TransAlta's rate base in 1990; that revenue contribution from export sales is sufficient to cover the cash carrying costs of coal rights and leases held for future potential power plants; that the sunk costs of Keephills Units 3 and 4 be shared equally between customers and shareholders; that the life span of steam generating plants be reduced from 40 years to 35 years for the purposes of depreciation; that the rate of return on common equity be 13.5% for all 3 years; that TransAlta's proposal to capitalize economy energy earnings be denied; and that TransAlta file a method of refunding an expected revenue surplus for 1990. 49 tabs.

25920 (BCH–90-00542) **BC hydro annual report 1989.** British Columbia Hydro, Vancouver, BC (Canada). [1990]. 60p. (MICROLOG–90-00542). Available from PC B.C. Hydro, 970 Burrard St, Vancouver, BC, CAN V6Z 1Y3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This annual report presents information on the year's activities, particularly in the area of customer service. The annual survey established that 85% of the customers had a positive image of B.C. Hydro. Other areas addressed include environmental protection, rates, the planning process, community involvement, the formation of advisory committees in the Peace River-Williston Lake area and the Columbia River, planning for interties with Puget Sound and Washington Water Power, installation of new transmisson lines and substations to service industry, and re-commissioning of the Burrard Thermal Generating Plant. Requests were also issued for private generating proposals, and the Power Smart program was initiated for residential, commercial and industrial users. Short descriptions of the various B.C. Hydro subsidiaries are included. A financial statement is given. 13 figs.,1 tab.

25921 (ENEA-RT-STUDI–89-01) **Italian electric power supply to the year 2000.** Manfra, L. Rome Univ. (Italy). May 1989. 67p. (In Italian). (RT/STUDI–89-1). Order Number DE90764320. Available from NTIS (US Sales Only), PC A04/MF A01.

This research deals with the structure of the electricity supply up to 2000, as it results out of the ENEL (Italian Electricity Board) and the National Energy Plan. The objective of the study is to analyze the options according to the different inputs of primary energy and the alternative technologies. The findings allow to define scenarios of cost minimyzing in electricity generation, associated with the different environmental impact assessment.

25922 (EPRI-GS/NP–6670) **Proceedings: 1988 conference on power plant simulators and modeling.** Divakaruni, S.M. (Electric Power Research Inst., Palo Alto, CA (USA)); Sursock, J.-P.; Sudduth, A. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA); Duke Power Co., Charlotte, NC (USA). c Feb 1990. 716p. Sponsored by Electric Power Research Institute. (CONF-8806165–: 1. EPRI conference on power plant simulators and modeling, Charlotte, NC (USA), 15-17 Jun 1988). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The first EPRI conference on power plant training simulators and modeling was hosted by Duke Power in Charlotte, North Carolina June 15–17, 1988. The conference focused on development and application of dynamic models of fossil and nuclear power plants for engineering analysis and operator training with particular emphasis on the EPRI developed Modular Modeling System (MMS). It was attended by over 150 participants representing a broad spectrum of domestic and foreign utilities, architect engineering firms, equipment vendors, engineering consultants, universities, and other interested parties. Attendees from the US and ten foreign countries delivered 49 technical papers and participated in three topical working group discussions. The technical sessions were grouped into six broad topics: simulator performance measurements; MMS fossil applications; nuclear training simulators; MMS nuclear applications; fossil training simulators; and engineering simulation and analysis codes. Three working group sessions were hold: nuclear simulators; fossil simulators; and engineering analysis and modeling. Each report will be cataloged individually.

25923 (MEA–90-00831) **The Manitoba Energy Authority seventh annual report for the year ended March 31, 1989.** Manitoba Energy Authority, Winnipeg, MB (Canada). [1990]. 19p. (MICROLOG–90-00831). Available from PC Manitoba Legislative Library, 200 Vaughan St., Winnipeg, MB, CAN R3C 1T5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The Manitoba Energy Authority is responsible for developing and implementing policies to ensure the long-term stability and availability of energy in the province. It is also responsible, through its Electrical Energy Marketing Committee, for negotiating export sales of electrical energy with other provincial utilities and with utilities in the USA. It is further responsible for promoting the establishment, development and operation of energy intensive industries within the province, and for coordinating all departmental and Manitoba Hydro activities related to industrial and employment benefits associated with the Limestone Generating Station Project. This report presents a summary of the Authority's activities for the year, including export agreements and negotiations and the associated sales figures. Financial statements of the Authority are also included. Some highlights include the continuing negotiations concerning a power export and diversity exchange agreement with companies associated with the Upper Mississippi Power Group in the USA; a review of the province's existing organization for contingency planning to ensure that the provincial agencies' efforts are adequately coordinated in the event of an energy crisis; and initiation of a commercial development program to verify and utilize advanced technologies in the manufacture of silicon products in Manitoba using local silica sand and hydroelectricity.

25924 (NERC–90009061) **Reliability of bulk electric supply: 1989/90 winter assessment.** North American Electric Reliability Council, Princeton, NJ (USA). c Nov 1989. 17p. Available from North American Electric Reliability Council, 101 College Road East, Princeton, NJ 08540-6601.

This assessment of bulk electric supply conditions for December 1989, and January and February 1990 was prepared from data and information provided by the nine Regional Reliability Councils. 3 figs., 2 tabs.

25925 (NERC–90009062) **1989 electricity supply & demand: Annual data summary for 1989–1998.** North American Electric Reliability Council, Princeton, NJ (USA). c Oct 1989. 174p. Available from North American Electric Reliability Council, 101 College Road East, Princeton, NJ 08540-6601.

The North American Electric Reliability Council (NERC) annually collects and publishes ten-year projections of electricity supply and demand of the nine Regional Reliability Councils. This 1989 Electricity Supply & Demand report provides this data for the 1989–1998 period. The projections were developed by the nine Regional Reliability Councils and generally reflect conditions as of January 1, 1989. Data on peak demand, net energy for load, capacity resources, capacity margins, and planned additions and retirements of generating units have been extracted from the April 1, 1989 Coordinated Bulk Power Supply Program (IE-411) reports submitted to the US Department of Energy by each Regional Reliability Council. Data on generating capacity, electrical energy production, fossil fuel requirements, and existing and planned additions of transmission lines were reported by the Regional Reliability Councils directly to NERC. Areas served by the nine Regional Reliability Councils are shown on the inside back cover of this report. Five of the Regions – MAIN, NPCC, SERC, SPP, and WSCC – are broken down into subregions. The regional and subregional abbreviations used throughout this report are defined on page 174. The codes used in the appendixes to describe generating unit additions and retirements are defined on page 173. Data for that part

of the Comision Federal de Electricidad system in the northern portion of Baja California, Mexico, which is interconnected with the US electric utility systems, is included under the category WSCC-Mexico or NERC-Mexico. This report also includes forecast bandwidths around the equal probability peak demand and annual net energy for load projections for NERC-US and NERC-Canada.

25926 (PNL-SA–17848) **End-use energy monitoring for evaluation.** Stoops, J.L. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. (CONF-9004134–3: Field monitoring for a purpose conference, Gothenburg (Sweden), 2-5 Apr 1990). Order Number DE90009450. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

As government agencies and utilities face ever tougher questions regarding the availability and persistence of energy savings from energy conservation and load management programs, reliable program evaluations become increasingly critical. Empirical data is the most robust indicator of program success or failure and is finding wide application in spite of the costs and time involved in field data collection projects. To obtain the desired results, monitoring projects must carefully apply the scientific method through well-controlled experimental procedures and project protocols.

2980 Consumption and Utilization

Refer also to citation(s) 25467, 25880

25927 (TNO-HMT–89-093) **The impact of telecommunication on traffic and transport.** Mot, E. (ed.). Hoofdgroep Maatschappelijke Technologie TNO, Apeldoorn (Netherlands). May 1989. 269p. (In Dutch). Available from Hoofdgroep Maatschappelijke Technologie TNO, P.O. Box 342, 7300 AH Apeldoorn, Netherlands.

An analysis is given of the influence of telecommunication on traffic and transport and, subsequently, on energy and environment for the Dutch situation. On the basis of three scenarios it is found that in the years 2000 and 2025, both substitution and generation effects can be foreseen. Effects of telecommunication decrease traffic and transport up to 15% in 2025, e.g. by substitution of commuter traffic, teleshopping, home education. On the other hand an increase up to 10% may be expected, e.g. due to spending of leisure. Hence, the net-effect is a reduction of 5%, approximately. The most important secundary effects are energy saving and reduction of harmful emissions. There are also positive by-effects, such as a decrease in noise nuisance, decreased fragmentation of nature and landscape, less car wrecks. The actual effect of telecommunication on traffic and transport, though, is larger than is suggested by the 5% mentioned earlier, since substitution effects mainly occur during rush-hours and generation effects outside rush-hours. This is of importance e.g. in relation with traffic congestion, future planning of infrastructure and environmental impact in urban areas. Further investigation would be required to analyse the possibilities of reinforcing the substitution effects, simultaneously weakening the generation effects. 15 figs., 70 refs., 99 tabs.

2990 Unconventional Sources and Power Generation

Refer also to citation(s) 25651, 25656, 25676, 25679, 25680, 26050

25928 (AFME-Z–0095-Vol.1) **Energy conservation, AFME-BECC workshop. Volume 1.** Cremieux, M.; Thomas, J.J.; Terminet Schuppon, B. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1986. 85p. (In French). Order Number DE90770651. Available from NTIS (US Sales Only), PC A05/MF A01.

The Chinese-French cooperation program concerning energy conservation was held in Beijing, 16-20 of June, 1986. A cooperation program between the AFME (French Energy Conservation Agency) and the Beijing Energy Conservation Center (BECC) is described in details. The main themes of the AFME mission in China are presented: rational use of energy in industry (wind turbines, variable speed motors, heat recovery, electric heating in textile industry), energy conservation in the transportation sector, methanic fermentation, heat networks and district heating with geothermal energy, waste heat, incineration, etc.

30 DIRECT ENERGY CONVERSION

3001 MHD Generators

25929 (AD-A–216276/6/XAB) **Magnetohydrodynamic liquid-metal flows in a rectangular channel with an axial magnetic field, a moving conducting wall, and free surfaces. Final report.** Talmage, G.; Walker, J.S.; Brown, S.H.; Sondergaard, N.A.; Burt, P.E. David Taylor Research Center, Bethesda, MD (USA). Nov 1989. 79p. (DTRC–89/019). Available from NTIS, PC A05/MF A01.

Fully developed, viscous liquid-metal velocity profiles and induced magnetic field contours were studied for Hartmann number of M=2 and 10 and for different load currents for a particular rectangular channel configuration (two-dimensional Couette flow). The rectangular channel was assumed to have a homogeneous external (axial) magnetic field parallel to the moving, perfectly conducting top wall and the stationary, perfectly conducting bottom wall. The two stationary side walls were also perfect conductors. The small gap between the moving wall and each side wall was an insulating, free surface. The method of weighted residuals was used to obtain truncated series solutions for the variables of interest. The heavy load currents across the channel were obtained by simulating an external potential to the conducting moving wall. The load currents in each case were opposed by the induced electric field. Since there is no pressure gradient, the flow along the channel is driven by the viscous effects of the moving wall and the Lorentz body force and is retarded by the stationary walls. The circulation is driven by the generator that is due to the axial variation of velocity in an axial magnetic field. The numerical data presented show that the radial gap and the free surface region represent electrical resistances in parallel between the perfectly conducting stationary wall and the perfectly conducting moving wall. Data were computed for one-dimensional Couette flow with no pressure gradient in an external, homogeneous axial magnetic field. One-dimensional Couette flow has no end effects, and thus the data were compared with corresponding data for the two-dimensional Couette flow case to determine and effects.

25930 **Development of a prototypical MHD coal combustor.** Listvinsky, G. (TRW, Inc., Redondo Beach, CA (USA)); Alpay, J.; Hill, L.; King, K.; Paul, D.; Vanevenhoven, P. D.; Natesan, K.; Wang, D.Y. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899497.

A 50 MW_t prototypical MHD coal fired combustor (CFC) is under development now at TRW. The prototypical combustor, while it is to be the same size as its predecessor work-horse, will be required to operate with high pressure, high temperature cooling water for improved thermal efficiency and it must be scalable to much larger sizes. In addition, it must have good potential for long-duration, reliable operation. It was found that in order to meet all of the requirements for the prototypical combustor, it was necessary to develop a design in which the thermal shield is separated from the pressure shell. Essential features of the new design are: gas pressure is contained by an uncooled shell made of stainless steel, and water cooled panels provide a thermal shield between the combustor gases and the uncooled pressure shell. A test section with 24 cooling panels has been designed and will be tested shortly in a 20 MW_t coal combustor to assess the concept viability. An experimental program is presently being conducted to evaluate the corrosion resistance of potential panel materials in both fire side and high-pressure water side environment. The paper provides a summary of the above mentioned efforts.

25931 **Axial current conduction in polarized slag layers on coal-fired MHD generator walls.** Lohrasbi, J. (Component Development and Intergration Facility, MSE, Inc., Butte, MT (US)); Lofftus, D. pp. 2950 of Proceedings of the 24th intersociety energy

conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899086.

The goal of the current study is to quantitatively examine a mechanism that produces high-voltage gaps on an MHD generator cathode wall that is otherwise shorted by metallic potassium. Results presented relate the amount of axial current required to produce high-voltage gaps along the cathode wall of the generator to the thickness and degree of potassium saturation of the slag layer along the wall. This work tends to conform the viability of the axial current model for opening high-voltage gaps on a coal-slagged channel.

25932 Coal-fired MHD topping cycle hardware development and test progress at the Component Development and Integration Facility. Hart, A.T. (MSE, Inc., Butte, MT (USA)); Glovan, R.J.; Stepan, I.E.; Richards, J.M. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899333.

The Component Development and Integration Facility (CDIF) is a DOE test facility operated by MSE, Inc. MSE is responsible for the integration of topping cycle components for the national coal-fired magnetohydrodynamics (MHD) development program. A 50-Mw_t, pressurized, slag-rejecting coal-fired combustor (CFPC) was added. Testing focused on CFC second-stage oxygen injector position checkout, Faraday testing, 100% slag carryover configuration, and CFPC checkout. This paper discusses test results, and facility upgrades/modifications made during the CFPC installation shutdown. Performance and development of the 1A test train hardware at the CDIF from March 1988, through March 1989 is described. This report describes a service history of the MSE nozzle. The status of diagnostic testing and hardware development testing in the diffuser is presented with some test results, and various developmental hardware designs.

25933 Experimental investigation on the effects of the TRW two-stage coal combustor on the performance of the AVCO Mk VI MHD generator. McClaine, A. (Avco Research Lab., Inc., Everett, MA (USA)); Pinsley, J.; Pote, B. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899498.

Coal-fired MHD power train testing at the Department of Energy's Component Development and Integration Facility (CFIF) in Butte, MT has resulted in different generator performance (power) than corresponding test with ash injected oil-fired combustor. This observation has led to an experimental investigation to resolve these differences in the Avco Mk VI MHD Generator Test Facility using engineering prototypes of the 59 MW_t hardware tested at the CDIF. The results of this ongoing investigation are reported and analyses of experimental data are presented which isolate plasma conductivity and plasma non-uniformity as the primary influences on the measured performance of the generator.

25934 Experimental program for investigation of high power density MHD. Lineberry, J.T. (The Univ. of Tennessee Space Institute, Tullahoma, TN (US)); Schmidt, H.J.; Chapman, J.N. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899574.

The University of Tennessee is conducting research on magnetohydrodynamic power generation under sponsorship through the Pittsburgh Energy Technology Center. This research is directed at the proof-of-concept of combustion MHD as a viable power source four use with space-based weapons systems. Currently, small scale laboratory evaluations of a solid aluminum, carbon fueled hybrid combustor is being finalized. Ultimate plans for this research include coupling of this combustor to an MHD generator to demonstrate high power density in the laboratory. This report includes experimental results from the initial hybrid combustor tests. The design of this combustor system and its design point are detailed. Experimental data from firings is presented and analyzed. The burn or regression rate for this fuel is summarized. The combustor tests have been successful. The design point for this system was readily achieved and sustained.

25935 Evaluation of materials for the MHD steam bottoming plant. Naatesan, K. (Argonne National Lab., IL (USA)); Swift, W.M. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899607.

Test data have been obtained on the corrosion of several commercial ASME-coded alloys and their weldments by exposing internally cooled ring specimens to simulated magnetohydrodynamics (MHD) environments. The specimens, coated with a K_2SO_4-rich deposit, were exposed for times up to 2000 h at metal temperatures of 762, 593, and 567°C to simulated MHD conditions for the intermediate-temperature air heater (ITAH), ITAH transition region (transition from a low- to medium-chromium alloy to a high-chromium steel), and secondary superheater (SSH), respectively. This paper discusses, in detail, the observed corrosion scale morphologies of various exposed specimens. Data on scale thickness, depth of intergranular penetration, and metal recession are presented, and the results are used to assess the corrosion behavior of various materials for application in the MHD steam bottoming plant.

25936 Design of a ten megawatt rocket driven disk MHD generator. Solbes, A. (TRW, Inc., Redondo Beach, CA (USA)); Weede, J.; Hession, R.; Mitchell, P. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899561.

This paper presents a ten megawatt rocket driven MHD disk generator system designed as part of the feasibility study of multimegawatt MHD space power systems for SDIO mission applications. The experimental system consists of a plasma generator/injector, a supersonic nozzle, a parallel wall disk channel, and a diffuser. The magnetic field is provided by a heat sink cryogenic magnet coil. Facility support systems include a reactant feed system, an exhaust system, and the required instrumentation and control system.

25937 Conceptual design of an MHD retrofit of the Corette plant Billings, Montana. Labrie, R. (MHD Development Corp., Butte, MT (USA)); Walter, F. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 6. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899499.

MHD burns coal with reduced emissions, at lower cost, with efficiencies in excess of 50 percent. The U.S. will need this new technology in about ten years to provide a clean coal alternative. The DOE Proof-of-Concept (POC) Program provides commercial prototype hardware testing and evaluation by 1993. This technology can then be demonstrated and commercialized before the year 2000. DOE proposed the conceptual design of a MHD retrofit plant as a way to ensure that the POC program would produce practical results. It will help guide the POC program to a successful conclusion. This paper presents the results of the conceptual design of an MHD retrofit for the Corette Plant in Billings, Montana.

3003 Thermoelectric Generators

25938 Advances in design and performance of SHE systems components. McBride, J.R. (Ford Motor Co., Dearborn, MI

(USA)); Novak, R.F.; Schmatz, D.J.; Copple, W.B.; Brockway, J.T.; Arnon, N.; Grab, G.A.; Hunt, T.K. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899500.

The Sodium Heat Engine is a thermoelectric energy conversion device that operates with no moving parts at conversion efficiencies projected to reach 25-30%. This paper reports recent progress in the design and performance of components used in the development of a 1000 Watt Sodium Heat Engine. Advances in long life electrodes, high temperature ceramic to metal seals, electromagnetic pumps, radiation shields, and current gathering systems are among the topics discussed.

25939 AMTEC recirculating test cell component testing and operation. Underwood, M.L. (Jet Propulsion Lab., Pasadena, CA (USA)); O'Connor, D.; Williams, R.M.; Jeffries-Nakamura, B.; Bankston, C.P.; Sievers, R.K. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 6. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899501.

Alkali Metal Thermoelectric Converter operation in a recirculating cell (RTC) requires a small electromagnetic pump (EM) and a high temperature β alumina solid electrolyte (BASE) to metal seal. This paper describes the design of an EM pump and an active metal braze seal as well as initial operation of a cell using these components. The EM pump delivered 0.25 cm^3/min against a 28 psia head. A braze seal system was selected after shear strength tests of Ta or Nb brazed to BASE by a variety of fillers including TiCuNi, TiNi, and TiNiCr. The TiCuNi filler was chosen for environment cell testing and showed no failure or observed degradation after short term tests up to 1055K. The EM pump and the Nb/TiCuNi/BASE seal were used in a test that demonstrated all the operational functions of the RTC for the first time at JPL. An increase in the radiation reduction factor at constant input power was observed indicating that the condenser was being wet by sodium resulting in an increased reflectivity.

3004 Thermionic Converters

Refer also to citation(s) 25776

25940 Some questions of uranium dioxide mass transfer influence on high-temperature fuel element behaviour. Gontar, A.S. (Research Technological Institute, Podolsk (SU)); Kucherov, R.Y.; Nelidov, M.V.; Nikolaev, Y.V.; Sotnikov, V.N.; Shulepov, L.N. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 6. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899308.

This paper describes methods and results of mass transfer computation in the central hole. These results give a possibility to outline temperature limit for using the central hole as the most simple gas venting system (GVS). At higher temperatures GVS in the form of a pipe with a tip having a capillary hole limiting uranium dioxide loss from the fuel rold is used. Usually geometrical parameters of such GVS are defined for stationary coonditions of operation, when the isothermal void is formed. In addition this paper gives the approach to the GVS-pipe length choice providing overheating of the tip relative to the fuel in the initial period of fuel element operation when the isothermal void is not formed. The dependence between time, that is necessary for formation of a through hole in a fuel layer, geometrical parameters of GVS and temperature of the tip is obtained. The other hand the value of the fuel element deformation in the case of such a failure is calculated.

25941 Indirect emitter temperature measurement. McVey, J.B. (Rasor Associates, Inc., Sunnyvale, CA (USA)); Hatch, G.L. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 6. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899221.

In-core tests of Thermoinic Fuel Elements (TFEs) seek to determine converter performance and the extent of emitter swelling. In order to evaluate both of these factors, it is crucial to know the emitter temperature accurately. Since a direct temperature measurement is virtually impossible, indirect methods based on analysis of the volt-ampere characteristics of a thermoinic cell are used. A method has been developed for accurately determining emitter temperature based on fitting calculated results to the unignited mode (diffusion mode) portion of the I-V curve. A computer-based data acquisition and analysis system is described. This system enables real-time emitter temperature determination to be done, as well as archiving data for future analysis.

25942 Recent measurements of the thermionic characteristics of duplex tungsten-niobium converters. Hatch, G.L. (Rasor Associates, Inc., Sunnyvale, CA (USA)); Desplat, J.L. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 6. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899219.

As part of the ongoing TFE verification program, thermionic converters are fabricated and performance mapped to establish the electrical properties. This includes both variable spacing planar and cylindrical converters with electrodes, duplex tungsten emitter and niobium collector. A computer controlled data acquisition system is used to record and store the performance and thermal efficiency of the series diodes. The results of performance-mapping as cylindrical converter with a cesium-graphite reservoir are given. The performance of the converter is compared with previous converters with similar electrodes. A stable cesium vapor pressure is established in the interelectrode space using the cesium-graphite reservoir at a temperature comparable to the collector temperature.

3005 Fuel Cells

25943 Material and fabrication challenges in the development of monolithic solid oxide fuel cells. Balachandran, U. (Argonne National Lab., IL (USA)); Dorris, S.E.; Picciolo, J.J.; Poeppel, R.B.; McPheeters, C.C.; Minh, N.Q. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 3. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899173.

Monolithic solid oxide fuel cells (MSOFCs) are presently under development for a variety of practical applications (e.g., advanced space and aerospace power systems; electric utility power generation). The MSOFC is composed of a honeycomb of very small cells, each 1 to 2 mm in diameter. The walls of the honeycomb are formed from thin (25 to 100 microns) ceramic layers of four cell components. The MSOFC imposes stringent requirements for stability, conductivity, compatibility, and thermal properties of the constituent materials at the operating temperature of about 1000°C. Successful fabrication of an MSOFC depends on incorporating the materials into a self-supporting structure at a higher sintering temperature. This paper discusses material properties, material requirements, and fabrication issues in the development of the MSOFC.

25944 Operation of phosphoric acid fuel cells on coal gases. Jalan, V, (ElectroChem, Inc., Woburn, MA (USA)); Poirier, J.A. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 3. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899373.

The objective of the project described here is to develop electrocatalysts that enable phosphoric acid fuel cells (PAFC's) to operate

on coal-derived gases, and thus increase coal utilization. The specific improvement sought is tolerance to poisoning by coal-gas contaminants such as carbon monoxide and hydrogen sulfide, this will lead to increased fuel cell operating efficiency and reduced fuel processing requirements. The authors' approach for reducing poisoning effects is to increase catalyst dispersion and decrease the adsorption affinity of the catalytic surface for CO and H_2S through the use of Pt alloys.

25945 **Development of low cost, carbon-supported carbon monoxide tolerant catalysts for phosphoric acid and proton exchange membrane fuel cell systems.** Kosek, J. (Giner, Inc., Waltham, MA (USA)); Kackley, N.; La Conti, A. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 3. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899253.

The use of hydrogen gas feeds derived from reformed hydrocarbons for use in low-temperature fuel cells requires extensive gas cleanup to remove contaminating species such as carbon monoxide. Advanced anode catalysts which are more tolerant to the presence of contaminant gases have been identified for use in phosphoric acid fuel cells. An extension of this work has led to the development of advanced low-cost anode catalyst systems for potential use in proton exchange membrane fuel cells. This development is discussed by the authors.

25946 **Application of the hanging meniscus rotating disk electrode method to oxygen reduction of plantinum in H_3PO_4.** Kroen, C.F. (Virginia Univ., Charlottesville, VA (USA). Dept. of Materials Science); Stoner, G.E.; Taylor, S.R. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 3. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899151.

The authors present results obtained using the hanging meniscus rotating disk electrode (HMRDE) method compared with those using the standard RDE method for the oxygen reduction reaction on platinum in H_3PO_4 at room temperature. Cyclic voltammograms and limiting current curves obtained from the HMRDE method were similar, but not identical, to those obtained from the standard method. A slight shape change was observed in the limiting current curves and non-linear Tafel plots were obtained for the HMRDE method. Discrepancies between the two methods seem to be related to the different hydrodynamics involved with the hanging meniscus. In spite of the present discrepancies, the HMRDE method shows some promise for determining comparative kinetic information at elevated temperature (200°C.).

25947 **Heat and mass transfer effects in PEM fuel cells.** Vanderborgh, N.E. (Los Alamos National Lab., NM (USA)); Huff, J.R.; Hedstrom, J. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 3. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899469.

Thermal and water management procedures in PEM fuel cells are described that influence stack performance. Using appropriate humidification and cooling strategies, stable high power density performance is predicted.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

Refer also to citation(s) 26652

25948 (PIRSEM–2031-1) **Study and elaboration of an efficient device measuring the contact resistance in certain exchanger technologies.** Bardon, J.P.; Bourouga, B.; Lhote, P.; Leroy, G. Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM). 1986. 55p. (In French). Order Number DE90770656. Available from NTIS (US Sales Only), PC A04/MF A01.

An experimental and analytical analysis of local contact resistance measuring methods is presented for three configurations of heat exchanger component: double thin tubes (thickness of about 1 mm), circular tubes with inserted fins (thickness of about 1/10 mm), flat tubes with brazed fins (thickness of about 1/10 mm or less). Transient state or steady state measuring methods are used and compared.

3201 Buildings

Refer also to citation(s) 25632, 25636, 25658, 25664, 25665, 25669, 25670, 25926, 26019, 26038, 26039, 26040, 26041, 26042, 26043, 26571

25949 (AD-A–216148/7/XAB) **Direct digital control of HVAC (heating, ventilating, and air conditioning) equipment (user's guide).** Kirts, R.E. Naval Civil Engineering Lab., Port Hueneme, CA (USA). Jan 1985. 94p. (NCEL-UG–0004). Available from NTIS, PC A05/MF A01.

Heating, ventilating, and air conditioning (HVAC) systems are now under going the most significant change in control technology in the past 100 years. This change is the introduction of direct digital control (DDC) to HVAC systems. Computer control has been introduced to many things over the past few years, from automobile engines to home appliances to most industrial processes, but only recently have small computer control systems been introduced into the space conditioning industry. To understand the implications of this new HVAC control technology, it is necessary to consider several questions: What is DDC and what are its capabilities. Under what conditions is DDC a cost effective alternative to conventional control. and What constitutes good system design and installation practice. This report addresses these questions by presenting information which describes DDC, presents its advantages and disadvantages, and gives applications guidance.

25950 (AD-A–216159/4/XAB) **Analysis of the advantages and disadvantages of the Air Force Standard Control Panel. Master's thesis.** Rumsey, K.E. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Systems and Logistics. Sep 1989. 302p. (AFIT/GEM/DEE–89S-15). Available from NTIS, PC A14/MF A02.

This study conducted research into the field of heating, ventilating, and air conditioning (HVAC) controls. Specifically, the research attempted to determine if the Air Force Standard Control Panel would aid in solving the Air Force's problems with complicated and unreliable HVAC controls. The research conducted an experiment and a Delphi survey of experts. The experiment compared the Standard Panel with a pneumatic built-up system. The analysis included a comparative investigation of the installation, calibration, and operations of each system and a statistical analysis and comparison of the drift of each system's mixed air and supply air controllers. The Delphi survey included eight experts in the controls field who were familiar with the Air Force Standard Panel. The survey included seven questions and was conducted in three rounds. No conclusion could be drawn from the statistical results of the experiment. However, the researcher concluded from the results of the qualitative portion of the experiment and the consensus of the Delphi experts that the Standard Panel was not superior to other controls systems in terms of design and installability (to include calibration) but was superior in terms of ability to maintain setpoint (to include overall operability) and diagnostics capability.

25951 (AFME–85-12-1079) **Computer-assisted-training softwares and energy conservation. State of the art and demand analysis.** Adnot, J. (Paris-7 Univ., 75 (France)); Arditi, I.; Demaiziere, F.; Lasserre, A.; Watremez, G. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France); Ecole Nationale Superieure des Mines, 75 - Paris (France). Apr 1987. 111p. (In French). Order Number DE90770654. Available from NTIS (US Sales Only), PC A06/MF A01.

The main objectives of this study were to examine the state of the art of the utilization of computers in the training of building energy conservation engineers, heat technicians and architects, to evaluate the needs in teaching software and to determine its development trends. A first approach concerned only the building envelope and equipments. Three types of training softwares are derived: training to physical and thermal properties of materials and equipments, training to the global design of a building and to the interactions between the different components, and the professional technical softwares adapted to pedagogical purposes.

25952 (AFME–86-06-0025) **CLIMAT: a meteorological data simulation code for building thermics.** Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1988. 79p. (In French). Order Number DE90770652. Available from NTIS (US Sales Only), PC A05/MF A01.

A simulation code that is to be used on personal computer by building engineers and thermicians is presented. Meteorological data such as temperature, nebulosity, wind speed, solar irradiation, vapour partial pressure, wind direction, and their inter relations are simulated from real statistical data measured on a 15 years period. The analysis of the statistical data is based on a "weather type" concept characterized by the evolution of the meteorological data during a medium type day.

25953 (BCME/CT–CE02955) **District of Surrey automated energy mangement project report.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). Conservation and Renewable Energy Branch; British Columbia Ministry of Energy, Mines and Petroleum Resources, Vancouver, BC (Canada). Conservation and Technology Div. [1984]. 22p. (CE–02955). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

In November 1981, the Municipality of Surrey was given a contract; under the Canada/British Columbia conservation and renewable energy demonstration agreement, to install a computerized building energy management system (BMS) at a central location with which to monitor and control the energy use in separate and different civic facilities via telephone lines (wireless links would have been feasible). The demonstration had three objectives: to establish the feasibility of centralized control via telephone lines, to collect energy performance data and thus, to determine the effectiveness of a BMS, and to reduce the energy costs to the municipal government. A Johnson Control JC/85/10 energy management computer was connected to seven separate buildings via telephone lines. The buildings represent 5 building types: 2 libraries, 3 swimming pools, 1 municipal office buildiing, 1 court house, and 1 low enforcement building. It took almost 6 months for the BMS to be fully installed in the facilities and an additional 6 months to fix it. An independent consultant was hired to evaluate the performance of the system in each building and thus, to determine its cost-effectiveness. Two periods of energy use were compared in the evaluation: May 1981 to April 1982 was the base year and September 1982 to August 1983 the demonstration year. The BMS was installed for a total cpital cost af about $123,000 and produced a first year energy cost savings of $38,600, yielding an average simple payback of 3.2 years. It was concluded that the demonstration was successful, and it is recommended that the federal governmnent provide further support to BMS demonstrations. 8 tabs.

25954 (BNL–43437) **Independent control of sensible and latent cooling in small buildings.** Andrews, J.; Lamontagne, J.; Piraino, M. Brookhaven National Lab., Upton, NY (USA). [1989]. 9p. DOE Contract AC02-76CH00016. (CONF-8910134–3: 6. annual symposium on improving building systems in hot and humid climates, Dallas, TX (USA), 3-4 Oct 1989). Order Number DE90008816. Available from NTIS, PC A02/MF A01 - OSTI.

This paper presents salient results of a utility-sponsored research project whose major objective was to identify all-electric technical means for energy-efficient independent control of sensible and latent cooling in residential and small commercial buildings, and to assess their technical and economic potential, including utility impact. 9 refs., 4 figs., 2 tabs.

25955 (CONF-891173–, pp. 11-18) **Perspectives on wind uplift.** Fricklas, R.L. (Roofing Industry Education Institute, Englewood, CO (USA)). Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

Wind behavior affects every segment of the roofing industry. While much is known about wind dynamics, we lack comprehensive understanding to apply this knowledge to roof designs. Problems include inadequate field data, poor correlation between laboratory and field performance, a lack of appropriate test methods to simulate the loading of single-ply ballasted and mechanically attached roofing systems, and a lack of effective communications between those who have information and those who need it. Some perceptions are offered on how the roofing industry feels about wind effects, and where the problems lie.

25956 (CONF-891173–, pp. 19-34) **Roofing membranes - observed damage, failure modes, failure hypotheses, and laboratory testing.** Gerhardt, H.J. Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

The basis for any realistic proof testing is sufficient knowledge about failures observed on real roofs. An interpretation of the failures has to lead to hypotheses concerning the failure mechanisms. This paper presents a testing procedure that has been developed by WSP consultants based on an extensive study of possible failure modes and failure hypotheses. The test apparatus and the wind load cycle used are explained. 6 refs., 16 figs., 1 tab.

25957 (CONF-891173–, pp. 35-45) **Realistic testing for wind resistance.** Cook, N.J. (Building Research Establishment, Watford (England)). Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

The paper describes the design and performance of a test rig capable of reproducing the fluctuations of surface pressure caused by wind action on areas of buildings and on building components. The wind-loading test equipment system can simulate any pattern of loading chosen on a full-size constructional unit. The test system is portable and computer controlled. The test rig will provide a proof check on the calculations of performance from codes of practice and other sources. For composite systems, where calculation is difficult or impossible, it will provide unique empirical performance information. 3 refs., 4 figs.

25958 (CONF-891173–, pp. 46-57) **NBI [Norwegian Building Research Institute] roof wind uplift strength test facility and load programs.** Paulsen, E.M. Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

In 1987, Norwegian Building Research Institute (NBI) initiated a project with participants from the four Scandinavian countries to study dynamic load applications on mechanically fixed roof systems. This paper concentrates primarily on giving a short description of the apparatus and loading conditions. A detailed pamphlet is also provide which shows how insulation and roofing membranes can be mechanically fastened to withstand wind loads. 5 refs., 6 figs.

25959 (CONF-891173–, pp. 58-60) **Roof attachment requirements based on field experience.** Baxter, R.P. (Carolina Roofing Services, Inc., Monroe, NC (USA)). Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

Field experience during recent heavy storms indicates that current recommendations for securing insulation for adhered roofing membranes are sufficient to minimize damage to the roof assembly. Present recommendations for securing mechanically attached

roofing membranes appear to be inadequate to minimize damage. More attention is required for recommendations to promote better attachment of perimeter wood and accessory metal, especially some proprietary metal coping assemblies. There is a definite need for relatively simple, understandable guidelines for roofing contractors, specifiers, and owners. Current recommendations are difficult to interpret and, especially in terms of fastening requirements, are confusing and indefinite. Details are not provided.

25960 (CONF-891173–, pp. 61-66) **Roof uplift mechanisms.** Peterka, J.A. (Colorado State Univ., Fort Collins (USA)). Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

Wind damage to single-ply membrane roofing systems is the result of fluctuating wind pressures on roofing elements and may be augmented by wind forces that dislodge ballast. The wind flows that induce roof loading are sufficiently complicated such that wind-tunnel tests are usually used to determine magnitudes of roof loading. Several wind-flow patterns, loading mechanisms, and failure modes are discussed. Possible research methodologies are presented to provide alternatives to a single testing facility for roofing certifications. 3 refs., 5 figs.

25961 (CONF-891173–, pp. 67-78) **Wind tunnel testing of roofs.** Kind, R.J. (Carleton Univ., Ottawa (Canada)). Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

This paper reviews what wind-tunnel testing has told us about the behavior of ballasted roofs. The review includes explanation of the mechanisms by which wind can damage ballasted systems. Current approval test methods do not simulate these mechanisms and are inadequate for ballasted systems. Possible new approaches to testing are briefly considered. 6 refs., 7 figs.

25962 (CONF-891173–, pp. 79-80) **Why is dynamic testing needed?.** Whelan, B.J. Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

Dynamic testing refers to tests whereby the roof assembly is exposed to vertical differential pressures that vary with time and intensity. It is needed: (1) to establish realistic fastener loads to prevent backout or pullout due to excessive fastener loading and for various deck types; (2) to account for fatigue behavior of fasteners, deck, and attachment systems; (3) to evaluate substrate behavior and membrane seams; and, (4) to account for decreasing membrane strength with increasing temperatures.

25963 (CONF-891173–, pp. 81-83) **How we use test results.** Gillenwater, R.J. Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

Discussion covers the procedures that are now in use and some of the various codes supplied as guidance. One methodology is to test until failure, and the other is testing to design load. Several questions are raised that will need to be addressed as dynamic testing to design load methods are finalized.

25964 (CONF-891173–, pp. 84-92) **How sample size affects factory mutual test results.** Smith, G.A. Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

Two static test procedures are discussed. Sample size is considered of major importance whether static or dynamic test procedures are used. 9 figs.

25965 (CONF-891173–, pp. 93) **Demystifying ballasted roofing systems.** Roodvoets, D.L. Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

Summary conclusions are provided: (1) Extensive wind tunnel data exists on the performance of ballasted systems; (2) Field experience has confirmed wind tunnel predictions; (3) Correlations of wind tunnel and field performance have only been done on a few modeled buildings, but correlation has been satisfactory; and, (4) alternate or new ballast design systems cannot be readily tested.

25966 (CONF-891173–, pp. 94-95) **Ballasted systems: Demystifying uplift performance.** Rhodes, K. Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

Based on the type of ballast and perimeter attachment, it is possible to resist scour and movement through wind velocities ranging from 80 to 100 mph. Using design concepts such as air retarders, sealed joints in the deck, and perimeter seals of the roof membrane can transfer all or a portion of the uplift load to various components of the roof system, roof deck, and building structure.

25967 (CONF-891173–, pp. 96-107) **Considerations for design of gravel ballasted systems.** Lankton, L.A. Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

Designs for wind resistance of loose-laid ballasted systems should consider two issues: (1) differential pressure created by the air film beneath the membrane in relation to the negative pressure created by the wind as it flows over the surface of the roof, and (2) scouring of the gravel ballast. In localized areas of high wind force, the stone can be displaced as a result of the force that is exerted. 1 ref., 10 figs., 2 tabs.

25968 (CONF-891173–, pp. 108-115) **Summary of presentation on paver performance factors.** Pardo, J. Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

Discussion covers paver and board systems utilized as ballast for single-ply roofing which provide a number of benefits not easily matched by other systems and not always obvious to designers and specifiers. 3 figs.

25969 (CONF-891173–, pp. 115-120) **Task group report field information.** Johnson, R.; Dupuis, R.; Gillenwater, R.J.; Hales, D.B.; McDonald, J.R.; Sheahan, J.P.; Smith, T.L. Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

A search was conducted for information on; (1) loss data from previous wind storms, (2) buildings that are or have been field instrumented, and (3) data from field instrumented buildings. Little information is available on losses and few buildings have been instrumented. Some instrumented buildings are discussed. Some recommendations are made.

25970 (CONF-891173–, pp. 121-132) **Research needs: Wind resistance testing of roofing systems.** Alumbaugh, R.L. Oak Ridge National Lab., TN (USA). Feb 1990. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. In *Proceedings of the roof wind uplift testing workshop.* Order Number DE90008041. Available from NTIS, PC A07/MF A01.

An agenda of research needs is presented and research issues on roof wind uplift resistance are discussed. 1 tab.

25971 (DOE/ID/12584–57) **Variation in the annual average radon concentration measured in homes in Mesa County, Colorado.** Rood, A.S.; George, J.L.; Langner, G.H. Jr. UNC Geotech, Grand Junction, CO (USA). Apr 1990. 36p. Sponsored by U.S.

DOE Nuclear Energy. DOE Contract AC07-86ID12584. (UNC/GJ–50(TMC)). Order Number DE90007980. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The purpose of this study is to examine the variability in the annual average indoor radon concentration. The TMC has been collecting annual average radon data for the past 5 years in 33 residential structures in Mesa County, Colorado. This report is an interim report that presents the data collected up to the present. Currently, the plans are to continue this study in the future. 62 refs., 3 figs., 12 tabs.

25972 (DOE/SF/15927–T3) **Optics and materials research for controlled radiant energy transfer in buildings: Progress report for reporting period ending March 31, 1990.** Goldner, R.B. Tufts Univ., Medford, MA (USA). 31 Mar 1990. 2p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG03-85SF15927. Order Number DE90008961. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This is a progress report on research programs to make buildings more energy efficient. Some of the projects are: window reflectivity; blockage of ultraviolet rays, materials testing, and ion beam dynamics. Materials studied included: $LiNbO_3$, WO_3, In_2O_3, and ZnO as a material to prevent Li from entering the transparent conducting layer. 3 refs. (FSD)

25973 (DW–2044) **Small commercial building energy retrofit: Final report.** Design Workshop, Moncton, NB (Canada). Feb 1985. 8p. (CE–02887). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The paper describes the retrofitting of modern energy conservation techniques and equipment to an older energy inefficient home in New Brunswick, undertaken to demonstrate the feasibility of converting houses into energy efficient office space. Thermographic photography of the exterior walls was performed, and insulation deficiencies (discovered around window frames and construction joints) were corrected. Two small air-to-air heat pumps were installed; one for the basement and main floor; the other for the second floor and attic. Task lighting was selected in favour of overall high level lighting. To overcome stand-by losses in conventional hot water tanks, instantaneous water heaters, which heat water only on demand, were used. The project successfully reduced energy consumption, lowering overall electrical consumption from 338 to 95.8 kWh/square metre. This level is competitive with the most modern commercial space. 1 fig., 3 tabs.

25974 (EC–2042) **Energy conservation in five convenience stores, New Brunswick.** Enerplan Consultants Ltd., Moncton, NB (Canada). Feb 1985. 55p. (CE–02963). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report describes a demonstration project on five small variety stores located in various centres throughout the province of New Brunswick. Retrofits in these stores concentrated on the following: improvements to the building envelope by insulating and air sealing with caulking and weatherstripping, improvements to lighting by replacement of old types of lamps with new more efficient lamps, heat reclaim of some of the heat rejected by the freezers and cooler units, and improvements to the space heating and cooling systems by replacement of old systems with new more efficient systems. This project demonstrated that the application of air/air heat pumps for small commercial buildings is a good one and should be encouraged. Air sealing, upgrading insulation levels, and addition of air-lock vestibules all contributed to energy efficiency and should be considered for similar retrofits. The utilization of waste heat from the refrigeration compressors proved beneficial. High pressure sodium exterior lighting is efficient, attractive and cost-effective.

25975 (GA–CE02990) **Energy efficient row housing, Yellowknife, N.W.T., Borealis Housing Co-operative.** Girvan and Associates Ltd., Consulting Engineers, Yellowknife, NT (Canada). [1990]. VP (CE–02990). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Borealis Housing Co-operative Ltd, in Yellowknife, Northwest Territories, consists of 50 pre-fabricated new town houses grouped into 9 blocks, ranging from duplexes to eight-plexes. The construction style is row housing on a common crawlspace. The project consisted of choosing the right position and orientation, ensuring airtightness, upgrading the thermal insulation, installing an air-to-air heat exhanger for the recovery of heat on the ventilation system, and installing triple-pane windows and an energy-efficient propane heating system. The project was partially founded by the Conservation and Renewable Demonstration Agreement Program. This report documents the construction, costs and benefits, technical and operational problems encountered, and their suitability or applicability for future projects. The data were primarily gathered through visiting the site during construction, monitoring the fuel consumption and receiving information from the tenants and architect. The data were compared to predictions made with the Hot-Canadian computer program. The results show that substantial energy savings can be realized in an energy-efficient have if the occupants are energy conscious. The capital cost to upgrade the units totalled Canadian $352,639. This amount will be recovered from fuel cost savings in 3.76 years. The initial response to the project has been positive, and the energy-conserving concepts, particularly the treatment of the exposed bedrock within the units, have other applications in Northern construction. 37 figs., 5 tabs.

25976 (IEA-HPC-R–6) **Engine-driven heat pumps. Analysis of existing systems.** Vinz, P. IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Dec 1989. 111p. Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.). Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.).

The goal of this report is to make available information to individuals involved in planning of engine driven heat pump (GHP) systems so that common problems which have occurred in the past will not be repeated. The procedure used to gather this information was to investigate a variety of existing systems to get a broad overview of the types of problems encountered. In all a total of eight systems were investigated in the Federal Republic of Germany ranging in heating capacity from 20 kW to 3 MW. Six of the systems are being used in the municipal sector for building heating. One of the systems is used in an industrial drying and cooling application while the eighth system is intended for residential use. Thus the conclusions and recommendations made in this report are mainly applicable to larger GHP systems used for building space heating. A detailed engineering analysis of each of the eight systems which involved investigations of the system's design, operating characteristics, and economics was carried out. Site visits and discussions with operating personnel and owners constituted the main source of information. Based on this information, detailed suggestions for improvement of each system are made, common problems identified, and general guidelines for future systems formulated. Finally the market prospects for these systems are discussed and a number of component development needs identified. Common problems among the systems investigated were categorized into the following areas: Preliminary design and system planning, start-up and operation, maintenance, and environmental aspects. (orig./UA).

25977 (KI–CE02894) **Energy blanket hot water heater insulation kit: Final report.** Key Industries Ltd., St. John's, NF (Canada). 1984. 6p. (CE–02894). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Energy Blanket project consisted of the manufacturing and marketing of a do-it-yourself water heater insulation kit which, when applied to domestic hot water heaters, adds an R value of R-8. The objective of the project was to make the general public aware of the fact that they could save energy and money by simply installing this blanket of insulation on their hot water tanks. The demonstration was successful to the extent that approximately 360 blankets were sold. The Energy Blanket sold for $30.00 and standby tests indicate that savings of as much as $10.00 per year could be realized, thereby giving a payback of 3 years. This slow payback rate for the original investment was regarded as a disincentive to consumer purchase of the blanket. 7 tabs.

25978 (LBL–26068) **An analysis of edge heat transfer in residential windows.** Arasteh, D. Lawrence Berkeley Lab., CA (USA). Oct 1989. 15p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. (CONF-891202–11: 4. thermal performance of the exterior envelopes of buildings, Orlando, FL (USA), 4-7 Dec 1989; TA–269). Order Number DE90009195. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

New window technologies are reducing heat transfer through the glazed areas of windows. Low-emissivity (low-E) coatings reduce radiative heat transfer and low-conductivity gas fills (which replace the air between glazing layers) reduce conductive heat transfer. Given these advances in insulating glass technology, researchers and manufacturers are now beginning to focus their attention on reducing heat transfer through window edges. Old edge designs are now under scrutiny and new designs are being proposed. This paper explores window material and design parameters which influence heat transfer using two-dimensional heat-transfer modeling with an advanced finite-element computer code (ANSYS). A comprehensive set of correlations, based on ANSYS parametrics, is then developed. These correlations are compared, whenever possible, to experimental results and will be incorporated into future versions of the WINDOW program. Glazing edge designs analyzed include both double-glazed and triple-glazed options with aluminum, steel, wood, fiberglass, butyl, and insulated spacers. Single and double design are also analyzed. 8 refs., 8 figs., 5 tabs.

25979 (LBL–27798) **Indoor radon and decay products: Concentrations, causes, and control strategies.** Nero, A.V. (Lawrence Berkeley Lab., CA (USA)); Gadgil, A.J.; Nazaroff, W.W. Lawrence Berkeley Lab., CA (USA). Jan 1990. 142p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90009214. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This report is an introduction to the behavior of radon 222 and its decay products in indoor air. This includes review of basic characteristics of radon and its decay products and of features of the indoor environment itself, all of which factors affect behavior in indoor air. The experimental and theoretical evidence on behavior of radon and its decay products is examined, providing a basis for understanding the influence of geological, structural, and meteorological factors on indoor concentrations, as well as the effectiveness of control techniques. We go on to examine three important issues concerning indoor radon. We thus include an appraisal of the concentration distribution in homes, an examination of the utility and limitations of popular monitoring techniques and protocols, and an assessment of the key elements of strategies for controlling radon levels in homes. 195 refs., 24 figs., 8 tabs.

25980 (MANECO–CE02884) **Artic Hotel retrofit and addition.** MANECON Partnership, Management and Economic Consultants, Edmonton, AB (Canada). May 1983. 39p. (CE–02884). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The paper describes an energy efficient retrofit to the Ikaluktutiak Cooperative Ltd. hotel in Cambridge Bay, Northwest Territories. It received a total of $22,000 from the Conservation and Renewable Energy Demonstration Agreement (CREDA). The project was an economic and technical success and the concepts demonstrated should be replicated in other northern building applications. The capital costs allocated to the enhanced energy measures totaled $35,169 cost savings in less than two years. The projected fuel savings, equal to 41% of the fuel needed without enhanced energy conserving measures, have been realized precisely as predicted. Condensation problems have occurred in the attic space of the second storey addition due to inadequate design of the attic space ventilation. The problem is not attributable to the increased building insulation. The concepts demonstrated by this project have been adopted in other ACL construction projects, and by some of the local building operators. Problems encountered included the following. The roof design for the hotel has not allowed for attic ventilation, and consequently attic frost build up and susequent condensation damage to the ceiling has occurred. The roof line vapour barrier does not form a complete enough seal to prevent moisture permeation into the attic space. The air-to-air heat exchanger installed to provide for energy efficient ventilation of the second floor conference room (35ft. x 30ft. x 7ft.) appears to be significantly undersized, and is therefore ineffective according to local Co-op management. The enhanced insulation concepts for new building construction and for retofit to existing structures are recommended for use in all NWT buildings. 2 refs., 6 tabs.

25981 (NBES–104) **Energy efficient home: Final report.** Miller, J. New Brunswick Energy Secretariat, Fredericton, NB (Canada); Department of Energy, Mines and Resources, Ottawa, ON (Canada). Feb 1985. 11p. (CE–02898). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The objective of this project was to provide a resonably priced energy efficient home using technology which was readily available, hopefully field proven or at least tested, and suitable for installation by local contractors. Specifically the dominant feature of the project is a continuous, sealed vapour barrier greatly reducing heat loss by air exchange. This is supplemented by high levels of standard insulation and the orientation of 84% of the glazed area to the south. Some deterioration in air quality was noted, however. The vapour barrier was highly successful when air quality is not considered. Similarly the passive solar feature was also successful. Finally the high R values of the fibreglass and cellulose insulation can be maintained for many more years because water vapour is unable to pass from the house into these areas. Such constuction should be easy to achieve in any area at little extra cost but with major reductions in the use of energy. These houses are quiet, free from draughts, warm in the winter, remain cool in the summer and can be architecturally pleasing to the eye.

25982 (NBES–2012) **Cordwood passive solar home, Tide Head, N.B.: Final report.** McRae, R. New Brunswick Energy Secretariat, Fredericton, NB (Canada). Feb 1985. 10p. (CE–02893). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Cordwood House was a project designed to demonstrate several technologies appropriate to the construction of single family homes. The two-storey building was designed using cordwood (or stackwood) construction to potentially use the landowner's own unprocessed timber. A sunspace is attached to the south facing wall of the house to act as a greenhouse and solar collector. Additionally, two commercially available collectors provided domestic hot water. A rock storage area in the basement served to capture any heat in excess of the needs of the building. At times when the building requires heat, the rock storage is tapped first before auxilary heat is called upon. In relation to its design requirements, the house had met the expectations of the owner. Even in the relatively severe winter season, the building uses less energy than similar sized units in the area. A group of professional energy conservation designers planned the building. The project was undertaken as a demonstration project by the Conservation and Renewable Energy Demonstration Program (CREDA). Cost savings are estimated as follows: new construction techniques save 30% over standard methods; passive solar heating reduces heating costs by over 50%; solar water heating save 75% over conventional means. The cost benefit analysis shows that initial and energy cost savings have been met.

25983 (NBES–2036) **Energy retrofit: Johnston House, Fredericton, N.B.: Final report.** New Brunswick Energy Secretariat, Fredericton, NB (Canada). Feb 1985. 11p. (CE–02889). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Johnston House Commercial Energy Retrofit involved the modernization of house built in the 1860's residence to usable office space. This was accomplished without altering the exterior appearance of the building. The project has been successful in demonstrating the value of retrofitting older structures to modern office space. In addition to preserving the historic value of the building, the conversion process has provided city core office space at rates less than existing rentals and much less than new

construction, assuming real estate can be purchased. The goal of eliminating oil consumption and converting the existing building into an energy efficient structure has been achieved with energy savings of $1000/yr. The space heating of 17 kWh/sq. ft. is very respectable given the age of the building. A procedure was established to convert the building to offices internally while restoring the exterior architectural details. The project incorporated moving stairwells, adding much more insulation and new triple-glazed windows, and replacing the oil furnance with an electric forced-air furnace. An air-to-air heat pump was added, which now supples most of the building's heat needs. The detailed cost benfit analysis showed that retrofitting older houses should be considered for persons seeking attractive downtown office space. 5 figs., 2 tabs.

25984 (OH/RD–88-157-K) **What's happening in the Utilization Section at [Ontario Hydro] Research Division.** Bell, J.M. Ontario Hydro Research Div., Toronto, ON (Canada). 8 Jul 1988. 31p. (MICROLOG–90-01729). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

This report gives an overview of the major activities in the Utilization Section at Research Division of Ontario Hydro, which provides technological innovation and support to improve customer benefits and power system utilization through developments in end-use technology. The system develops new applications of electricity, improves the efficiency and effectiveness of existing equipment, and determines the performance characteristics of new products. Activities are categorized by end user (industrial, residential, commercial), describing the goals, work program, deliverables, and future impacts of each project. Work in the industrial sector includes technology transfer, drying and concentrating processes, surface treatments, and materials and automation. Work in the residential and commercial sectors includes burner assisted, advanced cold climate and ground source heat pumps, water heating, heat recovery and thermal storage and building science. In addition, residential sector projects include demand solutions for electric heating and appliance and heat pump standards.

25985 (OME–90-01731) **Energy alternative for remote lodges and facilities.** Ontario Ministry of Energy, Toronto, ON (Canada). [1990]. 40p. (MICROLOG–90-01731). Available from PC Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Operators of lodges and recreational facilities in remote (off-grid) locations face many economic and logistical obstacles to providing attractive, comfortable accomodations for tourists. Space heating, hot water, electricity for lighting and other amenities are costly to provide in remote areas when using gas or diesel powered generators with with propane or kerosene heating to supplement wood fuel burning. This manual describes commercially available alternate energy systems and conservation opportunities suitable for Northern Ontario. Technical and economic information is included to help owners and operators identify and evaluate ways to effectively reduce their energy costs. This manual is intended to provide sufficient information to enable an owner/operator to make a preliminary assessment of the applicability of these alternate energy systems and energy conservation measures. Information about manufacturers and suppliers of products and services is included, as well as a number of sample projects. 27 figs.

25986 (ORNL/M–1100) **Building Thermal Envelope Systems and Materials (BTESM) and research utilization/technology transfer progress report for DOE [Department of Energy] Office of Buildings and Community Systems: Monthly progress report, February 1990.** Burn, G.; Samples, S.D. (comps.). Oak Ridge National Lab., TN (USA). Feb 1990. 80p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90010215. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Monthly Report of the Building Thermal Envelope Systems and Materials (BTESM) Program is a monthly update of both in-house ORNL projects and subcontract activities in the research areas of building materials, wall systems, foundations, roofs, building diagnostics, and research utilization and technology transfer. Presentations are not stand-alone paragraphs every month. Their principal values are the short-time lapse between accomplishment and reporting and their evolution over a period of several months. 267 refs.

25987 (ORNL/M–1117) **An experimental evaluation of two nonazeotropic refrigerant mixtures in a water-to-water breadboard heat pump.** Kauffeld, M.; Mulroy, W.; McLinden, M.; Didion, D. National Inst. of Standards and Technology (NEL), Gaithersburg, MD (USA). Center for Building Technology. Feb 1990. 64p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90009016. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

As part of the Department of Energy/Oak Ridge National Laboratory Building Equipment Research program, the National Institute of Standards and Technology constructed an experimental, easily reconfigurable, water-to-water, breadboard heat pump apparatus in order to compare pure R22 to nonazeotropic refrigerant mixtures. Performance of the heat pump charged with a range of compositions of the binary mixtures R22/RI14 and R13/R12 were compared to R22. The advantage claimed for mixtures in this application is improved thermodynamic efficiency as a result of gliding refrigerant temperatures in the evaporator and condenser in low lift, high glide applications typical of air conditioning. 9 refs., 24 figs., 4 tabs.

25988 (ORNL/Sub–88-SA835/1) **Research and development data to define the thermal performance of reflective materials used to conserve energy in building applications: Final report.** Desjarlais, A.O. (Holometrix, Inc., Cambridge, MA (USA). Thermatest Div.); Tye, R.P. Oak Ridge National Lab., TN (USA); Holometrix, Inc., Cambridge, MA (USA). Thermatest Div. Mar 1990. 249p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90010219. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

This is one of a series of reports to be published describing research, development, and demonstration activities in support of the National Program for Building Thermal Envelope Systems and Materials. The National Program involves several federal agencies and many other organizations in the public and private sectors who are addressing the national objective of decreasing energy wastes in the heating and cooling of buildings. Results described in this report are part of the National Program through delegation of management responsibilities for the DOE lead role to the Oak Ridge National Laboratory. 19 refs., 32 figs., 30 tabs.

25989 (PB–90-163007/XAB) **Feasibility of a complex compound heat pump. Final report, June 1986-September 1989.** Rockenfeller, U.; Kirol, L. Rocky Research Corp., Boulder City, NV (USA). Dec 1989. 88p. Available from NTIS, PC A05/MF A01.

See also PB–89-115273.

The feasibility of gas-fired heat pumps using ammonia refrigerant and complex compounds as a solid adsorbent has been evaluated. Feasibility was examined with respect to media vapor pressure, availability, stability, cost, and toxicity; reaction kinetics; heat pump cycles; thermal performance; and cost of a three-ton residential heat pump. Suitable media were identified and pertinent thermodynamic properties experimentally determined. Solid-vapor heat exchange hardware and methods were employed which resulted in power densities exceeding 1 kW/kg adsorbent. A double-effect cycle was selected for baseline performance evaluation, and reaction kinetics measured for all sorption reactions in the cycle, at actual cycle temperature conditions. Heat pump performance was evaluated with a computer model using experimental results for input parameters; cooling COPs from 0.8 to 1.1 are predicted. Manufacturing cost of a three-ton residential heat pump has been estimated to be $1200 to $1700.

25990 (PB–90-501198/XAB) **Federal Building Life-Cycle Cost (FBLCC) Program (for microcomputers). Software.** Peterson, S.R.; Bethea, W. National Inst. of Standards and Technology, Gaithersburg, MD (USA). Aug 1989. v. Available from NTISCP D01.

Supersedes PB–89-151203. The software is contained on 5 1/4-inch diskettes, double density (360K), compatible with the IBM PC microcomputer. The diskettes are in the ASCII format. Price includes documentation, PB–86-223104.

The Federal Building Life-Cycle Cost (FBLCC) Program provides computational tools and energy price data for performing life-cycle (LCC) analyses of Federal buildings and related subsystems. The method and procedures used in these LCC analyses are based on rules set forth by the U.S. Department of Energy Management Program and U.S. Office of Management and Budget. The FBLCC program (Vers. 2.3) contains the 1989 U.S. Department of Energy's energy price forecasts, as released in January 1990. The FBLCC program includes a number of changes in the Department of Energy's forecasts for the life-cycle cost analysis of Federal buildings. Software Description: The software is written in the BASIC programming language for implementation on an IBM/PC or compatible microcomputer under the MS-DOS operating system. Memory requirement is 64K.

25991 (PB–90-501206/XAB) **NBS (National Bureau of Standards) Life-Cycle Cost (NBSLCC) program (for microcomputers). Software.** Petersen, S.; Ruegg, R.T. National Inst. of Standards and Technology (NEL), Gaithersburg, MD (USA). Center for Applied Mathematics. Jan 1990. v. Available from NTISCP D01.

The software is contained on 5 1/4-inch diskettes, double density (360K), compatible with the IBM PC microcomputer. The diskettes are in the ASCII format. Price includes documentation, PB–86-180253.

The diskette provides the NBSLCC programs and related files referenced in NBS SP 709, Comprehensive Guide for Least-Cost Energy Decisions. The National Bureau of Standards Life-Cycle Cost (NBSLCC) programs perform economic analysis of buildings, building systems and components with special emphasis on energy conservation projects. The NBSLCC program (Vers. 2.32) contains the 1989 U.S. Department of Energy's energy price forecasts, as released in January 1990. The NBSLCC program has had a number of enhancements, including color screens and highlighted menus that make it easier for the user to decide what to do next. Several small bugs were removed from the program. Software Description: The software is written in the BASIC programming language for implementation on an IBM/PC or compatible microcomputer under the MS-DOS operating system. Memory requirement is 64K.

25992 (PIRSEM–3068-1) **Control and regulation of a building thermal system through the experimental measure of the thermal flux variations on the walls of a building.** Duthoit, B.; Herin, P.; Lassue, S.; Thery, P. Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM); Lille-1 Univ., 59 - Villeneuve-d'Ascq (France). 1987. 65p. (In French). Order Number DE90770658. Available from NTIS (US Sales Only), PC A04/MF A01.

The main objective of this experimental study was to analyze the energy transfers on the internal surfaces of a building wall in order to regulate and control the heating system of the building. A simple proportional controller is used to regulate the resulting temperature in a room, by the measure of the thermal and radiative balances on a heavy wall. The energetic gains are controlled as a function of the instantaneous radiative transfers between the walls, independently of the thermal inertia of the walls.

25993 (SEMR–20) **The Weyburn Conservation: The retrofit and rehabilitation of a 1929 ballon - framed house with full concrete basement: Final report.** Saskatchewan Dept. of Energy and Mines, Regina, SK (Canada). [1984]. 56p. (CE–02967). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report gives details of the retrofit work conducted on a house in Weyburn, in southern Saskatchwan as part of the Conservahome Project. The Project involved the retrofit and rehabilitation of six houses of various ages and styles, and was funded by CREDA: The federal-provincial Conservation and Renewable Energy Demonstration Agreement. The selected house had a relatively good basement, for its age. Also, it awas located close to the down-town core and therefore had good demonstraion potential. The Weyburn Conservahome was built in 1929 and contained many of the features common to this vintage. Retrofit activities were implemented in the basement, exterior walls, attic, doors and windows, furnace, waterheater and fireplace. 14 figs.

25994 (SEMR–FP-13) **Saskatoon low energy market housing project: Final technical report on a renewables-conservation demonstration program project.** Saskatchewan Dept. of Energy and Mines, Regina, SK (Canada). [1984]. 55p. (CE–02885). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The paper describes the Saskatoon Low Energy Homes Project, a group of 14 passive solar, low energy houses constructed by mainstream building contractors. Its purpose was to determine if conventional home builders could incorporate low energy techniques into conventional designs, and produce low energy houses for the mass housing market. It was shown that this was possible, while the associated demonstration raised public awareness of the possibilities of this technology. The existing plans suffered from the following common shortcomings: ceiling sometimes sagged due to high insulation loadings above; there was a general lack of detailed information on the installation of the and air-vapour barrier; and lack of information on air-tight furnance rooms on double wall construction. These problems were solved in the design stage. Complete heat loss calculations were done for each house using several techniques. While the demonstration did not immediately convert the house-buying public, the project provided data for the formulation of government programs and policies to encourage adoption of low energy housing. 23 refs., 5 figs., 16 tabs.

25995 (SWEG–36) **Implications of installing a combined Heat and Power Unit -methodology applied to a day centre in Cornwall.** Crabb, J.A. (Exeter Univ. (GB). Energy Studies Unit). South West Energy Group, Exeter (UK). Mar 1987. 15p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Measurements of the heat and electricity demand profiles at the site indicate that it would be possible to install a 26 KWR combined heat and power (CHP) unit with an expected saving in energy costs of approximately Pound 2500 per annum. At an estimated installation cost of Pound 16,600 this implies a payback period of 6.7 years. However, it is noted that major assumptions are built into this assessment. The demand profiles are unreliable as an indication of typical consumption because of disruption in normal site generation at the time of measurement. Consumption of gas and electricity for 1985/86 is assumed to be typical of the future, the export of surplus electricity during periods of high heat demand is assumed and night time CHP will not be considered as purchased electricity is the cheaper operation at night. The present major limitation is the relatively low site electricity demand. It is concluded that it would be better financially to find a legitimate on-site use for the surplus electricity rather than to export it. (UK).

25996 (SWEG–37) **A method for examining potential CHP applications.** Crabb, J.A. (Exeter Univ. (GB). Energy Studies Unit). South West Energy Group, Exeter (UK). Apr 1988. 9p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

The detailed assessment of prospects for the installation of a CHP unit is a complicated and time consuming task. It involves measurement of electricity and heat demand profiles and the prediction of daily and monthly CHP production. The effect on energy bills can then only be assessed from a detailed consideration of the relevant tariffs. To minimize on wasted effort some method of initial selection is needed to identify the sites for detailed assessment which have the best chance of proving favourable. Such a procedure must obviously, in the cause of brevity, beg many of the detailed questions which would be addressed in a full assessment. Nevertheless, some hard facts must be considered and even an abbreviated assessment involves some effort. We thus find that a

three stage process would be the most workable, with the first stage weeding out the very worst prospects on the basis of some simple guidelines. This note outlines proposals for the first two stages of such a system. The third stage has already been developed and is summarized in a previous report. (author).

25997 (SWEG–38) **Energy targeting for schools. Phase 1: Analysis of historical data.** Penman, J.M. (Exeter Univ. (GB). Energy Studies Unit). South West Energy Group, Exeter (UK). Sep 1988. 39p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

This is a report on the use of historical data in energy targeting for school buildings. It aims firstly to see what useful indices of performance can be extracted from the historical data itself, and secondly to establish a basis for comparing historical data with theoretical energy targets being developed in the second phase of this project. The report relies on monthly gas and electricity consumptions over the past six to seven years at six secondary school in Devon. These data are collected by the utilities for billing purposes and are supplied routinely to the energy management team at Devon County Council. (author).

25998 (SWEG–39) **Energy targeting for schools. Phase 2: Methodology for theoretical targeting.** Penman, J.M. (Exeter Univ. (GB). Energy Studies Unit). South West Energy Group, Exeter (UK). Oct 1988. 30p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

A practical methodology for theoretical targeting is demonstrated by application to a local authority school in Exeter, whose historical space heating consumption is shown to be consistent with the theoretical expectations. (author).

25999 (SWEG–40) **Experience with a heat pump and thermal store heating system in a primary school.** Crabb, J.A. (Exeter Univ. (GB). Energy Studies Unit); Dods, G. South West Energy Group, Exeter (UK). Oct 1988. 36p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Natural gas is the preferred heating fuel for most new schools. In many rural locations, however, natural gas is not available and under these circumstances electrically powered heat pumps might be considered as an alternative to an oil-fired system. The economic case is strongest if the provision of a thermal store allows the major portion of the purchased electricity to be acquired at night at off-peak rates. An experimental system employing air-source heat pumps and a water store has been installed by Devon County Council at Bradworthy County Primary School. The performance of this system has been routinely monitored for the three heating seasons since it first became operational in November 1985. The potential for using heat pump/heat store systems in other similar buildings is examined. (author).

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Refer also to citation(s) 25841, 26505

26000 (AD-A–216108/1/XAB) **Identification of HVAC (heating, ventilating, and air conditioning) deficiencies using analysis of job order data. Master's thesis.** Ellis, T.M. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Systems and Logistics. Sep 1989. 109p. (AFIT/GEM/DEM–89S-8). Available from NTIS, PC A06/MF A01.

The objective of this research study was to develop a systematic and objective procedure to identify HVAC deficiencies at Robins AFB, GA. Statistical analysis of HVAC repair data was used to indicate where and when HVAC deficiencies had occurred based on the potential for cost savings. The statistical models which were developed are only applicable to Robins AFB. However, the procedures used to identify HVAC deficiencies could be repeated at any base that maintains historical HVAC repair data. The research also explored the use of the procedures developed as a tool for the HVAC Evaluation Group. The research showed that job order analysis provided a useful means for identifying HVAC deficiencies. Facility square footage and historical job order data were used to predict the expected number of job order hours within specific facility groups. These groups were established based on similarities among facilities in the HVAC job order data. The differences between the expected hours and the actual hours was then used to prioritize HVAC deficiencies based on the potential for reducing job order hours and thus the potential for cost savings.

26001 (AD-A–216275/8/XAB) **Vehicle acceleration and fuel consumption when operated on JP-8 fuel. Interim report, 1 June 1988-28 February 1989.** Owens, E.C.; Yost, D.M.; Lestz, S.J. Southwest Research Inst., San Antonio, TX (USA). Belvoir Fuels and Lubricants Research Facility. Feb 1989. 47p. (BFLRF–257). Available from NTIS, PC A03/MF A01.

A limited test program (eight combat and tactical vehicles) was conducted to obtain a quantitative estimate of the change in combat and tactical vehicle performance and fuel consumption that would occur when converting the military fleet to MIL-T-83133 JP-8 (F-34) fuel. Data specifically desired included startability and idle quality, acceleration rates, and fuel consumption. Also, a comparative assessment of the on-vehicle smoke production capabilities of combat vehicles with the two fuels was desired. As a result of these tests, it was determined that substitution of JP-8 for DF-2 reduced the acceleration rates, and thus power, of all vehicles tested except for the M928 and M1009 vehicles, which improved or remained the same. Also, all vehicles tested, except for the M88A1 light recovery vehicles, had fuel consumption increases with JP-8 that were at or below that predicted by the heating value difference between the two fuels. No drivability or idle problems occurred with any of the test vehicles.

26002 (ANL/ESD–2) **Transportation projects with energy, economic, and environmental benefits: Innovative uses of oil overcharge and other funds.** Mintz, M.M. (Argonne National Lab., IL (USA). Energy Systems Div.); Zerega, A.M. Argonne National Lab., IL (USA). Energy Systems Div. Oct 1989. 79p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. Order Number DE90007895. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Since 1974, the United States has made significant progress in improving energy efficiency. The average new car travels more than 10 miles farther on a gallon of fuel; commercial aircraft fly the same number of passenger-miles on 30% less fuel; and trucks and railroads transport the same number of ton-miles of freight on 20% less fuel. One area of continuing concern, however, is transportation's almost total dependence on petroleum-based fuels. Between 1974 and 1988, transportation's share of US petroleum consumption rose from 51% to more than 63%. As domestic oil production declines and the United States depends more on imported oil, this trend is becoming increasingly serious. Energy conservation may be the only feasible near-term alternative for reducing transportation's oil consumption and US vulnerability to disruptions in oil supply. Further, because transportation vehicles are major sources of urban congestion, pollution, and so-called "greenhouse" gases, saving energy in transportation can have important social, economic, and environmental benefits. 15 figs., 1 tab.

26003 (BCME/CT–CE02954) **Energy aspects pertaining to the 50 kV electrification of the British Columbia Railway Tumbler Ridge branch line.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). Conservation and Renewable Energy Branch; British Columbia Ministry of Energy, Mines and Petroleum Resources, Vancouver, BC (Canada). Conservation and Technology Div. Mar 1984. 23p. (CE–02954). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

In 1975/76, the British Columbia Railway began design studies on rail access to the north east coal basin to transport coal to Prince Rupert, B.C. Electrification was considered as an alternative to tunnel ventilation in the proposed tunnels, but the additional rock excavation required made the project appear unfeasible. In April 1982, it was found that the operating costs, capital savings, and financial assistance available made feasible use of 50kV, 60 Hz

electified railroad technology. The project is described. The catenary system run along the entire length of the Tumbler Ridge Branch Line, including the 4 tunnels, and includes the load-out loops at the mine sites. The length of catenary is approximately 150 km. By using a 50 kV catenary voltage, only one substation is required. The 230/50 kV subsation is built at km 112, so as to provide a direct connection to B.C. Hydro and to allow for the expansion of the rain line eastward as more coal fields are developed. The substation and catenary systems were substantially built in 1983 and their completion is scheduled for 1984. The energy clculations presented in this report are based on computer simulations of the trains running on the Tumbler Ridge Branch Line. The energy comsumption is expected to be reduced by 63% by the conversion from diesel fuel to hydro-generated electricity. The funding available from by the Conservation and Renewable Energy Demonstration Program gave an added incentive to the project. The overall performance of the system will be evaluated over the next year. The locomotive efficiency is being tested using a test car provided by General Motors of Canada. The demonstration aspects of the project are underlined. 2 refs., 1 fig., 6 tabs.

26004 (DOE/ET/32043–T31-Vol.1) **Final safety analysis report for the ulysses mission: Volume 1, Reference designn document.** General Electric Co., Philadelphia, PA (USA). Astro Space Div. Mar 1990. 160p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC01-79ET32043. (ULS-FSAR–002). Order Number DE90008693. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The Final Safety Analysis Report (FSAR) II consists of three volumes which are related to the safety analysis of the Ulysses mission: Volume 1, Reference Design Document (RDD); Volume 2, Accident Model Document (AMD); and Volume 3, Nuclear Risk Analysis Document (NRAD). An Executive Summary pertaining to Volumes 1 and 2 is also provided. Volume 1, this document, provides the background design information required to understand the analyses presented in Volumes 2 and 3. It contains descriptions of the RTG, the Ulysses spacecraft, the Space Shuttle, the Inertial Upper Stage (IUS), the Payload Assist Module — Special (PAM-S), the trajectory and flight characteristics including flight contingency modes, and the launch site. There are two appendices in Volume 1 which provide detailed material properties for the RTG. 19 refs., 117 figs., 19 tabs.

26005 (DOE/ET/32043–T31-Vol.2-Bk.1) **Final safety analysis report for the Ulysses mission: Volume 2, (Book 1) accident model document.** General Electric Co., Philadelphia, PA (USA). Astro Space Div. Mar 1990. 121p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC01-79ET32043. (ULS-FSAR–003). Order Number DE90008694. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The status of the accident analysis for the Ulysses outer planetary space science mission is presented in this Final Safety Analysis Report (FSAR). This mission employs a Radioisotope Thermoelectric Generator (RTG) as the prime electrical power source for the spacecraft. Ulysses will be launched into Earth orbit using the Space Shuttle and will use the Inertial Upper Stage (IUS)/Payload Assist Module – Special (PAM-S) boosters to place the spacecraft into an Earth escape trajectory. The RTG employs silicon-germanium thermoelectric couples to produce electricity from the heat energy that results from the decay of the radioisotope fuel, Plutonium-238, used in the RTG heat source. The heat source configuration used in the RTG is termed General Purpose Heat Source (GPHS), and the RTG is designated GPHS-RTG. The use of radioactive material in these missions necessitates evaluations of the radiological risks that may be encountered by launch complex personnel as well as by the Earth's general population resulting from postulated malfunctions or failures occurring in the mission operations. The FSAR presents the results of a rigorous safety assessment, including substantial analyses and testing, of the launch and deployment of the RTG for the Ulysses mission. 14 refs., 24 figs., 18 tabs.

26006 (FO/FDHM–1988/89-146) **Energy Sea Program - 1988/89 vessel analysis computing system.** Pinhorn, P. Department of Fisheries and Oceans, St. John's, NF (Canada). Fisheries Development Div. May 1989. 43p. (MICROLOG–90-01594). Available from PC Fisheries and Oceans Canada, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The Ener Sea project was conceived as a means of training Newfoundland inshore fishermen (those operating vessels less than 65 feet long) on methods for reducing their energy costs. Four main activities were conducted as part of the Ener Sea program from June 1988 to March 1989. They included propeller analysis, cost reduction/energy efficiency seminars, demonstrations at sea and vessel remeasurement. Propellers on 44 fishing vessels were analyzed and the vessel analysis computing system (VACS) was demonstrated. Twenty seminars were held throughout Newfoundland Region with a total of 258 fishermen in attendance. It was determined from the data on 18 vessels which had demonstrations conducted at sea that a reduction of 1 knot from maximum speed would result in an average fuel savings of 43%. The estimated impact of the Ener Sea program on the Newfoundland fishing fleet in 1988/89 amounts to total savings of approximately $246,870. In addition, 3 vessels were measured a 2nd time to verify the accuracy of the propeller program. It was proven that the program predicted RPM at a determined speed with 2.8% accuracy. 9 figs., 4 tabs.

26007 (NUS–5249) **Final safety analysis report for the Ulysses Mission: Executive summary.** NUS Corp., Gaithersburg, MD (USA). Mar 1990. 25p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC01-87NE32134. (ULS-FSAR–001). Order Number DE90008690. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document is a condensed version of the information presented in the Ulysses Mission Final Safety Analysis Report (FSAR). An earlier Safety Status Report (January 31, 1990) presented interim information to support NASA's Environmental Impact Statement for the mission. It was the best information available at the time the National Environmental Policy Act (NEPA) process required for timely support of NASA's decision making process. Section 1 of this Summary Report is a brief description of the Ulysses Mission. Section 2 contains descriptions of the Ulysses spacecraft, the Radioisotope Thermoelectric Generator that provides electrical power to the scientific instruments, radios, and control systems, and a description of the launch vehicle. Section 3 is a summary description of the Ulysses mission accident analyses and risk assessment and their results. 5 figs., 5 tabs.

26008 (NUS–5250-Vol.3-BK.1) **Final Safety Analysis Report for the Ulysses Mission: Volume 3 (Book 1), Nuclear Risk Analysis Document.** NUS Corp., Gaithersburg, MD (USA). Mar 1990. 39p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC01-87NE32134. (ULS-FSAR–005). Order Number DE90008691. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of the Nuclear Risk Analysis Document (NRAD) is to provide an analysis of the range of potential consequences of accidents which have been identified during the launching and deployment of the Ulysses mission spacecraft. The specific consequences analyzed are those associated with the possible release of radioactive material (fuel) of the Radioisotope Thermoelectric Generator (RTG). They are in terms of radiation doses to people and areas of deposition of radioactive material. These consequence analyses can be used in several ways. One way is to identify the potential range of consequences which might have to be dealt with if there were to be an accident with a release of fuel to assure that, given such an accident, the health and safety of the public will be reasonably protected. Another use of the information, along with accident and release probabilities, is to estimate the risks associated with the mission. That is, most space launches occur without incident. Given an accident, the most probable result relative to the RTGs is complete containment of the radioactive material. Only a small fraction of accidents might result in a release of fuel and subsequent radiological consequences. The combination of probability with consequence is risk, which can be compared to other human and societal risks to assure that no undue risks are implied by undertaking the mission. 5 refs., 13 figs., 4 tabs.

26009 (NUS–5250-Vol.3-BK.2) **Final safety analysis report for the Ulysses Mission: Volume 3 (Book 2), Nuclear risk analysis document—Appendices.** NUS Corp., Gaithersburg, MD (USA). Mar 1990. 194p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC01-87NE32134. (ULS-FSAR–006). Order Number DE90008692. Available from NTIS, PC A09/MF A01 - OSTI.

This appendix describes the methods used in evaluating the radiological consequences and the integrated mission risks presented in the Nuclear Risk Analysis Document (NRAD), Book 1. Since the location of an accident having a release is important to the type of accidents that are possible, the amount of release, and to the consequences of that release, each mission phase is analyzed separately. Mission Phases 0 and 1 are on the launch pad or during early ascent in the Cape Canaveral area. Consequence analyses during these phases make use of meteorological, demographic, and land use data for the Kennedy Space Center (KSC) and environs. Phase 2 involves the possibility of a failure during later ascent with a reentry and impact along an African ground track. An accident during Phases 3 and 4 can result in a reentry anywhere within the 28° north 28° south latitude bands. A worldwide data base has been used for the accident consequence analyses for mission Phases 2, 3, and 4. The specific data used for these analyses are contained in Appendices C, E, F, and G. 17 refs.

26010 (PB–90-138728/XAB) **National urban mass-transportation statistics: 1987 Section 15 annual report. Transit financial and operating data reported for fiscal years ending between January 1, 1987 and December 31, 1987. Annual report.** Shorter, R.; Ammann, W.C. Compex Corp., Alexandria, VA (USA). Sep 1989. 641p. Available from NTIS, PC A99/MF A04.

See also PB–89-160097.

The report summarizes the financial and operating data submitted to the Urban Mass Transportation Administration by the nation's public transit operators, pursuant to Section 15 of the Urban Mass Transportation (UMT) Act of 1964, as amended. The report also includes a subset of Section 15 data compiled for the Section 9 apportionments. Section 9 is a formula grant program for capital, operating, and certain other assistance created by the Surface Transportation Assistance Act of 1982 (which amended the UMT Act) and reauthorized by the Surface Transportation and Uniform Relocation Assistance Act of 1987. The report consists of four chapters. Chapter 1 contains an introduction to the Section 15 reporting system and its relationship to the Section 9 program. Chapter 2 contains aggregate industry statistics derived from the complete Section 15 reports which were submitted. Chapter 3 contains financial and operating data on the individual transit systems that submitted complete Section 15 reports. Chapter 4 contains the operating statistics that were compiled for the FY 1989 Section 9 apportionments. All data in the report are for transit years ending on or between January 1 and December 31, 1987.

26011 (PB–90-145657/XAB) **Transit fare prepayment: A guide for transit managers. Research report.** Mayworm, P.D.; Lago, A.M. Ecosometrics, Inc., Bethesda, MD (USA). 4 Jan 1983. 175p. (RR–125-8). Available from NTIS, PC A08/MF A01.

Transit fare prepayment programs grew rapidly during the past decade with most companies today offering riders several prepayment options. The growth has not been without its costs. The manual provides transit managers with the information and tools necessary to make informed decisions on the design and pricing of fare prepayment plans. Included is information on the true benefits and costs of operating fare prepayment plans. Guidelines on selecting the appropriate plans and distribution methods are presented, as are guidelines on pricing fare prepayment plans in order to capture passenger revenues. A series of straightforward equations are also provided to assist the transit manager in estimating the impacts of changes in a fare prepayment program. The report contains a glossary of terms, a bibliography and a discussion of some fare prepayment demonstration projects.

26012 (PB–90-146432/XAB) **National urban mass transportation statistics. 1987 Section 15 annual report. Report for 1 January-31 December 1987.** Shorter, R.; Ammann, W.C. Compex Corp., Alexandria, VA (USA). Sep 1989. 641p. Available from NTIS, PC A99/MF A04.

Also available from Supt. of Docs.

The report summarizes the financial and operating data submitted to the Urban Mass Transportation Administration (UMTA) by the nation's public transit operators, pursuant to Section 15 of the Urban Mass Transportation (UMT) Act of 1964, as amended. The report also includes a subset of Section 15 data compiled for the Section 9 apportionments. Section 9 is a formula grant program for capital, operating, and certain other assistance created by the Surface Transportation Assistance Act of 1982 (which amended the UMT Act) and reauthorized by the Surface Transportation and Uniform Relocation Assistance Act of 1987. The report contains an introduction to the Section 15 reporting system and its relationship to the Section 9 program, aggregate industry statistics derived from the complete Section 15 reports which were submitted, financial and operating data on the individual transit systems that submitted complete Section 15 reports, and the operating statistics that were compiled for the FY 1989 Section 9 apportionments. All data in the report are for transit years ending on or between January 1 and December 31, 1987.

26013 (PB–90-148693/XAB) **Urban rail transit projects: Forecast versus actual ridership and costs. Final report.** Pickrell, D.H. Transportation Systems Center, Cambridge, MA (USA). Oct 1989. 164p. Available from NTIS, PC A08/MF A01.

Substantial errors in forecasting ridership and costs for the ten rail transit projects reviewed in the report put forth the possibility that more accurate forecasts would have led decision-makers to select projects other than those reviewed. The study examines the accuracy of forecasts prepared for ten major capital improvement projects in nine urban areas during 1971-1987. Each project includes construction of a fixed transit guideway: Rapid Rail or Metrorail (Washington DC, Atlanta, Baltimore, Miami); Light Rail Transit (Buffalo, Pittsburgh, Portland, Sacramento); and Downtown Peoplemover (Miami and Detroit). The study examines why actual costs and ridership differed so markedly from their forecast values. It focuses on the accuracy of projections made available to local decision-makers at the time when the choice among alternative projects was actually made. The study compares forecast and actual values for four types of measures: ridership, capital costs and financing, operating and maintenance costs, and cost-effectiveness. The report is organized into 6 chapters, numerous tables, and an appendix that documents the sources of all data appearing in the tables presented in the report.

26014 (PB–90-151044/XAB) **Ferry pricing strategies analysis. Final report.** Ulberg, C. Washington State Transportation Center, Seattle, WA (USA). 6 Nov 1989. 75p. Available from NTIS, PC A04/MF A01.

The report describes the results of research on ridership response to various fare pricing strategies. The research builds on the analysis of fare elasticity conducted by the Washington State Transportation Center (TRAC) under contract with the Washington State Department of Transportation (WSDOT). The basic objective of the study was to provide information from which to predict changes in revenues with changes in the fare structure. Specific recommendations for an efficient and equitable fare structure require knowledge about more than the fare elasticities. The fare structure needs to reflect policies concerning the provision of mobility to island residents, achievement of a desirable ratio of revenue to operating costs, an optimal vehicle and walk-on passenger mix, and the like. However, fare elasticities can be used to explore the implications of different polices designed to address these issues. To achieve a higher degree of certainty in the findings and to make quantitative estimates of revenue impacts of fare changes, a different approach is required than the one used in the study. Data need to be collected on a disaggregate basis. The report outlines how the research should be carried out.

26015 (PB–90-151374/XAB) **People mover for Atlantic City: Issues, impacts, markets, costs, and criteria.** Brail, R.K.; Burchell, R.W.; Walker, C.C.; Schwartz, A.; Dunn, J.A. Rutgers–the State Univ., New Brunswick, NJ (USA). Center for Urban Policy Research. Oct 1989. 372p. Available from NTIS, PC A16/MF A02.

The report analyzes the critical issues relating to the development of an automated guideway transit (AGT) system or peoplemover in Atlantic City, New Jersey. It estimates the demand for and costs of a peoplemover system, explores potential revenue

sources for funding a system, examines the public issues germane to the question of whether and how such a system can be implemented, and ultimately, will assist decision-makers to determine whether or not the peoplemover concept deserves further attention. The study team collected data and opinions on issues, surveyed markets, developed cost/revenue models, and looked into the legal and environmental implications of this potential new local transportation improvement. Interviews were also conducted with AGT system suppliers and transportation officials from other cities. The report discusses: the history and issues surrounding AGT development; more technical concerns of markets and costs/revenues; a formal evaluation methodology for selecting a franchisee to build a peoplemover system in Atlantic City. The appendix provides a bibliography on peoplemovers.

3203 Industrial and Agricultural Processes

Refer also to citation(s) 25437, 25438, 25608, 25634, 25635, 25657, 25954, 25976, 25984, 25987, 26032, 26278, 26780

26016 (BCME/CT–CE02958) **Hammond Bay Greenhouses demonstration project.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). Conservation and Renewable Energy Branch; British Columbia Ministry of Energy, Mines and Petroleum Resources, Vancouver, BC (Canada). Conservation and Technology Div. [1990]. 9p. (CE–02958). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Hammond Bay Greenhouse Demonstration Project was an attempt to demonstrate an innovative commercial greenhouse heating system which had the potential to result in significant energy savings. The project was funded under the Canada/British Columbia (B.C.) Conservation and Renewable Energy Demonstration Agreement and was initiated in 1980. Hammond Bay Greenhouses is a commercial tomato greenhouse operation located near Nananimo, B.C. The heating system being demonstrated consisted of circulating hot water heated by an oil-fired boiler through steel piping within a plywood enclosure. As the potted tomato plants were suspended within this enclosure, the growing medium was kept warm. This enabled the greenhouse air temperature to be lowered, after the tomato plants had been planted, thereby reducing the heat loss from the greenhouse. The initial estimates of the energy savings were in the order of 50% for the 25 m x 62 m greenhouse. However, operational changes since this estimate would suggest lower savings. Unfortunately, at the time of this report, no valid monitoring results were available, due to monitoring equipment malfunction. The tomato production with the innovative heating system, however, has been a pleasant surprise and has average 13% greater than the production under the reference heating system. 2 figs., 1 tab.

26017 (CA–2018) **Energy conservation demonstration potential in the food and beverage industry in New Brunswick.** Cogeneration Associates Ltd., Toronto, ON (Canada). Jan 1985. 44p. (CE–02964). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

Concerns expressed by the Food and Beverage industry in the past few years over energy supply and prices have prompted many plant managers to direct their attention to the efficiency with which energy is being used in producing goods and services. Industry is attempting to hold down the total cost of energy by increasing efficiency. This increased efficiency in energy use is accomplished by many methods, some of which are as follows: improved housekeeping and maintenance, use of new materials or improved and more efficient processes and equipment, recycling of materials, modification of existing equipment, use of cogeneration, reduction of energy losses in boilers, ovens, steam pipes, retorts, recovery of waste heat from industrial processes. Cogeneration Associates Limited were engaged to identify two demonstration projects in the Food and Beverage industry which would be suitable for Conservation and Renewable Energy Demonstration Assistance Program (CREDA) financing, and to assist the selected plants in preparing a proposal. A survey of thirty-two establishments was undertaken by means of a mail questionnaire and plant visits. Nineteen projects were identifed which showed suitable payback periods. Two projects, Connors Bros. and Carapec Ltd., were selected for further study and detailed proposals were prepared. Connors Bros. submitted a proposal for funding and was successful in obtaining 65% of the total capital cost of $202,000 as a contribution from the CREDA progream. The Connors project demonstrates hot air recovery, hot water recover, and electricity load management. The total energy saving of the project will be $80,000 year, giving a pay-back period of 2.5 years. 6 figs., 1 tab.

26018 (CB–2032) **Fish packing plant energy management project, Connors Brothers Ltd., Blacks Harbour, N.B.** Connors Bros. Ltd., Blacks Harbour, NB (Canada). Dec 1984. 68p. (CE–02962). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This is the final report on the Energy Management System project completed at Connors Bros., Ltd No. 10 Sardine Plant in Blacks Harbour, N. B.. In order to further reduce energy usage Connors Bros., felt the need for more sophisticated means of monitoring major potential energy waste areas. On December 7, 1981 an application was forwarded to the N.B. Energy Secretariat's office requesting financial assistance under their Conservation and Renewable Energy Demonstration Program (CREDA). The assistance was to demonstrate the potential energy savings in fish plants such as Connors Bros., through heat recovery and improved energy management. The technologies to be demonstrated were combined into one integrated energy management system. The system was based on automatic monitoring and controlling of energy usage with the use of a programmable controller and microcomputer. The technologies demonstrated included: heat recovered from hot air sources in the plant, heat recovered from hot waste water, load management of electrical equipment, monitoring and control of the system using a programmable controller, and analysis and system performance evaluation using a microcomputer. The project was economically successful. Savings of $79,500/y were achieved with a capital cost of $202,000 giving a payback of 2.5 years. In addition, this capital cost could have been reduced has the project not been intended for demonstration purposes. The technologies demonstrated worked successfully. Any of the technologies may be implemented individually or in groups. 3 figs., 5 tabs.

26019 (CONF-900334–3) **Triple-effect absorption chiller cycle: A step beyond double-effect cycles.** DeVault, R.C. Oak Ridge National Lab., TN (USA). [1990]. 15p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From 3. International Energy Agency heat pump conference; Tokyo (Japan); 12-15 Mar 1990. Order Number DE90008910. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Many "advanced" absorption cycles have been proposed during the current century. Of the hundreds of absorption cycles which have been patented throughout the world, all commercially manufactured products for air conditioning buildings have been variations of just two basic absorption cycles: single-effect and condenser-coupled double-effect cycles. The relatively low cooling coefficients of performance (COPs) inherent in single-effect and double-effect cycles limits the economic applicability of absorption air conditioners (chillers) in the United States. A triple-effect absorption chiller cycle is discussed. This cycle uses two condensers and two absorbers to achieve the "triple effect." Depending on the absorption fluids selected, this triple-effect cycle is predicted to improve cooling COPs by 18% to 60% compared with the equivalent double-effect cycle. This performance improvement is obtained without increasing the total amount of heat-transfer surface area needed for the heat exchangers. A comparison between the calculated performances of a double-effect cycle and a triple-effect cycle [both using ammonia-water (NH_3/H_2O) as the absorption fluid pair] is presented. The triple-effect cycle is predicted to have an 18% higher cooling COP (1.41 compared with 1.2 for a double-effect), lower pressure [47.70 atm (701 psi) instead of 68.05 atm (1000 psi)], significantly reduced pumping power (less than one-half that of the double-effect cycle), and potentially lower construction cost

(33% less total heat exchange needed). Practical implications for this triple-effect cycle are discussed. 16 refs., 5 figs., 1 tab.

26020 (ENEA-RT-PAS–89-23) **Mobile systems for waste treatment and environmental decontamination.** Beone, G.; Mincarini, M. ENEA, Casaccia (Italy). Dipt. Protezione Ambientale e Salute dell'Uomo. Sep 1989. 50p. (In Italian). (RT/PAS–89-23). Order Number DE90764291. Available from NTIS (US Sales Only), PC A03/MF A01.

This paper surveys and describes the operating characteristics of a variety of mobile hazardous waste processing units employed worldwide to carry out environmental monitoring, collection and treatment of oil from spills, in-situ treatment of processing plant sludges, neutralization and solidification of hazardous substances, incineration, etc.

26021 (ENEA-RT-TIB–89-05) **Simulation of hot rolling of a 5 mm steel plate with ABAQUS code.** Zucchini, A. ENEA, Bologna (Italy). Dipt. Tecnologie Intersettoriali di Base. Apr 1989. 24p. (RT/TIB–89-5). Order Number DE90764306. Available from NTIS (US Sales Only), PC A03/MF A01.

The numerical simulation of metal forming processes (rolling, extrusion, deep drawing, etc.) is a problem not completely solved at present despite its large industrial interest: a design tool of this type would greatly improve the optimization of the punch and die and produce a better quality workpiece at lower costs and in a smaller time than the usual empirical 'trial and error' procedure. Many different FEM codes exist nowdays with some capabilities of this type, but a single efficient design instrument combining the requirements of accuracy, computational speed, ease of use and economy is not available yet. This work is the first step of an ENEA (Italian Commission for Alternative Energy Sources) project addressed to the setup of such a tool. The rolling of a 5 mm steel plate was simulated by means of the elastic-plastic plane strain model of the FEM code ABAQUS. The results for different reduction ratios and friction coefficients are compared to available experimental data.

26022 (EPRI-CU–6740) **Guide for the selection of supermarket refrigeration systems: Final report.** Walker, D.H. (Foster-Miller, Inc., Waltham, MA (USA)); Tsaros, T.L.; Deming, G.I. Electric Power Research Inst., Palo Alto, CA (USA); Foster-Miller, Inc., Waltham, MA (USA). c Mar 1990. 290p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report presents an evaluation of supermarket refrigeration involving the use of conventional and multiplex compressor systems. Computer simulations of these systems were performed for six representative sites. The performance predictions generated in this fashion were tabulated to allow hand calculation of electric costs for any prevailing electric rate schedule. A methodology was also developed to allow economic assessment of the conventional and multiplex systems and of various enhancements employed with the multiplex system. The results of the evaluation showed the multiplex refrigeration system produced a reasonable payback for all sites examined, depending upon the enhancements employed. System features that had the greatest impact on payback were heat reclaim, hot gas defrost, and floating head pressure. 25 figs., 28 tabs.

26023 (LA-UR–90-515) **Application of neural nets to system identification and bifurcation analysis of real world experimental data.** Adomaitis, R.A. (Princeton Univ., NJ (USA). Dept. of Chemical Engineering); Kevrekidis, I.G.; Farber, R.M.; Lapedes, A.S.; Hudson, J.L.; Kube, M. Los Alamos National Lab., NM (USA). Feb 1990. 13p. Sponsored by U.S. Department of Defense; National Science Foundation; Packard Foundation Fellowship; Commonwealth of Virginia Center for Innovative Technology. DOE Contract W-7405-ENG-36. (CONF-900398–1: 1990 international conference on neural networks, Lyons (France), Mar 1990). Order Number DE90007539. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We report results on the use of neural nets, and the closely related "radial basis nets", to analyze experimental time series from electro-chemical systems. We show how the nets may be used to derive a map that describes the nonlinear system, and how reserving an extra "input line" of the network allows one to learn the system behavior dependent on a control variable. "Pruning" of the network after training appears to result in elimination of spurious connection weights and enhanced predictive accuracy. Subsequent analysis of the learned map using techniques of bifurcation theory allows both nonlinear system identification and accurate and efficient predictions of long-term system behavior. The electrochemical system that was used involved the electrodissolution of copper in phosphoric acid. This system exhibits interesting low dimensional dynamics such transitions from steady state to oscillatory behavior and from period-one to period-two oscillations. This analysis provides an example of methodology that can be fruitful in understanding systems for which no adequate phenomenological model exists, or for which predictions of system behavior given a large scale, complicated model is inherently impractical. 17 refs., 2 figs.

26024 (ME–89-06063) **Cogeneration sourcebook.** MacLaren Engineers, Inc., Willowdale, ON (Canada). Sep 1988. 64p. (MICROLOG–89-06063). Available from PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This source-book is intended to help facilitate the implementation of private and public sector cogeneration projects in the Province of Ontario. It discusses the technical basis of cogeneration, how to assess the feasibility of cogeneration, the applicable regulations and approval, ownership and financing, the contracts for the sale of energy (with examples), and where assistance should be obtained for planning and implementing cogeneration projects. It also describes the requirements for connection with the electrical grid. Among the appendices are lists of consultants, manufacturers and suppliers, and third-party financial institutions. 20 figs., 3 tabs.

26025 (OME–90-01350) **The potential for cogeneration in the commercial sector.** Ontario Ministry of Energy, Toronto, ON (Canada). Apr 1989. 141p. (MICROLOG–90-01350). Available from PC Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The commercial sector is the third largest user of electricity in Ontario, using 21% of the total electricity demand in 1985. Cogeneration is one option available to commercial establishments such as large hotels and motels, restaurants, supermarkets and recreational facilities to improve energy efficiency and benefit from energy cost savings or revenues resulting from the sale of electricity to the province's grid. It has been estimated that 460 MW of cogeneration capacity, economically viable on the life-cycle basis, could be developed in the commercial sector by 2000. This report identifies, assesses the impact, and ranks the most attractive cogeneration opportunities in various commercial establishments where cogeneration would be a viable option given current market conditions and emerging technologies; identifies the types of buildings considered and their energy requirements, selecting preferred building categories for further assessment of cogeneration potential; reviews current and emerging system technologies; identifies the various factors affecting economic viability, including an economic and sensitivity analysis of the systems; and summarizes building owner and operator requirements and identifies barriers to cogeneration systems implementation. It was discovered that, at present, the utility and cogeneration package costs do not make commercial cogeneration a feasible alternative for Ontario. However, it is felt that trends in the technology which are bringing down installed costs will make cogeneration an important option within the next 10 years. 30 refs., 4 figs., 13 tabs.

26026 (PB–90-147869/XAB) **Fayette Power Project-Waste Heat Aquaculture Feasibility Study. Final report.** Johnson, M.C.; Ekstrom, J. Lower Colorado River Authority, Austin, TX (USA). 30 Jun 1988. 106p. Available from NTIS, PC A06/MF A01.

Color illustrations reproduced in black and white.

The aquaculture industry in Texas is growing steadily and has potential for future development. The Waste Heat Aquaculture Feasibility Study for the Lower Colorado River Authority Fayette Power Plant is the culmination of a two year effort that includes detailed

discussion and analysis on the viability of a commercial aquaculture operation at the Fayette Power Plant, with special consideration of impacts on plant operation and security, legal and permitting constraints, water rights and other pertinent issues. The study discusses opportunities for private investment, includes site development recommendations and provides preliminary development designs.

26027 (PB–90-148008/XAB) **Evolution of the US iron and steel industry and the implications for natural gas. Final report, January 1987-August 1989.** Charles River Associates, Inc., Boston, MA (USA). Aug 1989. 317p. (CRA–217). Available from NTIS, PC A14/MF A02.

CRA quantified the effect on future gas use of various levels of steel demand, likely structural industry changes, fuel substitution, steel production source, and technology development. Two sets of technical innovation were established evolutionary and revolutionary technology developments. The energy impacts of revolutionary developments were explicitly forecast. Increased use of blast furnace injection of natural gas and increased use of gas for steel scrap melting will be major elements of natural gas use in the 1990s. However, the use of both of these technologies is sensitive to the overall level of steel output. In the 1990s, fuel substitution will be a greater determinant of energy market shares than will novel technologies, due in part to their expected low penetration by the year 2000.

26028 (PB–90-159765/XAB) **Direct injection of natural gas in blast furnaces at high rates: Analysis of historical operating data at Warren Consolidated Industries, Inc. Topical report, July-september 1989.** Agarwal, J.C.; Brown, F.C.; Chin, D.L.; Frydenlund, A.R.; Sinek, J.R. Charles River Associates, Inc., Boston, MA (USA). Sep 1989. 73p. (CRA–476). Available from NTIS, PC A04/MF A01.

Historical blast furnace operating data at Warren Consolidated Industries, Inc. were analyzed to serve as a baseline for future high-rate injection experiments. Data on furnace performance were examined for consistency, and rationalized material balance data were used as inputs to a blast furnace energy balance model. The model was used to analyze furnace performance and interpret the effects of injecting natural gas as a supplemental fuel. Data indicate the potential to achieve increased productivity and reduced cost for the integrated steelmaker through the use of higher rates of natural gas plus oxygen injection in the blast furnace. Results show a replacement ratio of up to 1.8 pounds of coke per ton of hot metal (lbs/THM). The furnace was operated for long periods of time at natural gas levels of about 150 lbs/THM with no indication of any operating problems, and the results of the energy balance analysis suggested that still higher rates are feasible. Field data indicate the need to conduct additional controlled experiments to confirm and further explore affects on productivity, coke replacement ratio, and operations from gas injection rates up to 250 lbs/THM.

26029 (UCRL-ID–103120) **Waste Minimization Plan, Building 141 Special Processing Facility, Electronic Manufacturing Group.** Sato, H.C.; Hersey, R.J. Lawrence Livermore National Lab., CA (USA). 5 Feb 1990. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (LER–89-1012-01). Order Number DE90010205. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Electronic Manufacturing Group has developed a plan to minimize hazardous waste produced by its Special Processing Facility in building 141. This facility is used to manufacture printed wiring boards, to chemically machine products, and to do metal finishing for electronic assemblies. The plan's goal is to attain compliance with environmental, health, and safety regulations and, wherever possible, to implement appropriate substitute processes, chemicals, and materials that will minimize hazardous waste production and approach zero hazardous waste discharge. 9 figs., 3 tabs.

26030 Improving the efficiency of electricity use in manufacturing. Ross, M. (Argonne National Lab., IL (USA)). *Science (Washington, D.C.) (USA)*, 244(4902): 311-317 (21 Apr 1989).

Largely in response to the energy shocks of the 1970s, U.S. manufacturers reduced their real fossil fuel intensity (the weighted-average ratio of energy use to production in each subsector) by 50% and achieved zero grown in real electricity intensity. In the future, adoption of new technologies for increasing the efficiency of electricity use is likely to continue to be as important as new modes of electrification, implying that the real electricity intensity will be stable; but the outcome depends on electricity pricing and other policies, public and private. 34 refs., 4 figs., 2 tabs.

3206 Municipalities and Community Systems

Refer also to citation(s) 25727

26031 (DOE/CE/26576–3) **District cooling via commercial energy center development: The experience of United Resources, Inc.: Final report.** United Resources, Inc., New Haven, CT (USA); Fleming Group, East Syracuse, NY (USA). 8 Dec 1989. 30p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-88CE26576. Order Number DE90005333. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The specific scope of this report is to document the findings and experiences of URI's development of satellite energy centers in the City of New Haven. Innovative technologies and development approaches for district cooling have been an integral part of the URI's efforts. These have included analyses of alternate cooling technologies, system development approaches, strategic development planning, energy and environmental considerations, customer and provider economics, and marketplace competition. This report focuses on the exploration of cooling technologies that are compatible with the satellite energy center approach and the market place experiences of URI in the development of two energy centers. The subjects include: a discussion of the satellite energy center development approach; descriptions of compatible and innovative cooling technologies; evaluation of energy, environmental and economic issues related to the technologies; and a discussion of the marketing, contracting, designing, financing and construction experiences of URI. It is the intent of this report to provide technological information and marketplace experience that can provide guidelines to URI and others in future development of district cooling systems.

26032 (ENEA-RT-PAS–89-17) **Use of solid urban waste combustion ashes as a partial substitute for cement.** Balzamo, S.; De Angelis, G.; Marchetti, A. ENEA, Casaccia (Italy). Dipt. Protezione Ambientale e Salute dell'Uomo. Jul 1989. 15p. (In Italian). (RT/PAS–89-17). Order Number DE90764372. Available from NTIS (US Sales Only), PC A03/MF A01.

In this feasibility study on the use of fly ash for cement, the influence of the addition of ashes on the workability of the mix and the hydration reactions of cement components was evaluated and a series of tests was conducted on the products containing about 14% by weight of ashes. Mechanical properties, porosity and permeability of the solidifies ashes were formed to be comparable with the ones related to common cement products. The test for determining the release of pollutants, made with 0.5M acetic acid, evidenced that fragments of the sample release an excess of some toxic elements. Additional tests, concerning the resistance to freezing-and-thawing cycles and long-term leachability, are under way in order to demonstrate the durability of the product obtained.

26033 (PB–90-148164/XAB) **City of Forks waste-to-energy feasibility study. Final report.** Forks, City of, WA (USA). Nov 1988. 127p. Available from NTIS, PC A07/MF A01.

The goal of the study is to evaluate the feasibility of a waste-to-energy plant in the Forks area, considering economic, technical, environmental and public acceptance factors. The study goes into considerable detail in documenting the development of four solid waste and five wood waste scenarios. The authors' analysis shows a wood waste pile burner coupled with a lumber drying kiln to be the most economically feasible wood waste scenario. A solid waste recycling and incineration facility at the Clallam Bay Corrections Center ranked third, followed by an incinerator for Forks' waste only. It is recommended that the City begin discussions with the County regarding interim transfer and disposal of solid waste after the November 1989 closure of the Lake Creek landfill.

26034 (PB–90-148248/XAB) **Solid-waste-to-energy feasibility study. Final report.** South Western Oklahoma Development Authority, Burns Flat, OK (USA). Aug 1988. 45p. Available from NTIS, PC A03/MF A01.

The report presents the results of a solid waste-to-energy feasibility study that addresses the technical, legal, financial, and regulatory factors involved in planning and implementing such a waste management system in a target area in Southwestern Oklahoma. The study reveals that under current conditions of low cost energy and adequate landfill space, a regional waste-to-energy operation would not be feasible. The high capital costs of even a minimal system would not be feasible for serving one or even two cities of 10,000 to 15,000 population each.

26035 (PB–90-157769/XAB) **Facing America's trash: What next for municipal solid waste.** Office of Technology Assessment (U.S. Congress), Washington, DC (USA). Oct 1989. 380p. (OTA-O–424). Available from NTIS, PC A17/MF A02.

Also available from Supt. of Docs.; Library of Congress catalog card No. 89-600716.

Increasing amounts of municipal solid waste, declining landfill capacity, public opposition to all types of management facilities, concerns about the risks associated with waste management, and rising costs are common problems facing communities across the Nation. As a result, there is increasing awareness about the need to prevent municipal waste from being generated in the first place and to better manage what is generated. Many communities, States, businesses, and public interest groups are undertaking a variety of activities to address these needs. The challenge to improve the situation ranges from actions by individuals to supportive policies at the Federal level. The report discusses options for a national policy based on the dual strategies of MSW prevention and better management. It also presents options to address immediate problems such as increased interstate shipments of MSW and unfinished Federal guidelines for landfills and incinerators.

26036 (PB–90-159070/XAB) **Municipal solid-waste needs assessment. Final report. Report for 1988-1989.** Ross, B.; DeVries, A.; Humphreys, B. Science Applications International Corp., Bothell, WA (USA). Sep 1989. 119p. Available from NTIS, PC A06/MF A01.

The final report examines the needs (technical, educational, and policy) of municipal solid waste managers in Alaska, Washington, Oregon, and Idaho. Four state profiles of solid waste management (and one profile for Indian tribes) indicate the variety of needs across the region. Washington and Oregon needs are concentrated in finding markets for recyclable materials, while Idaho and Alaska need more basic technical assistance in siting and building landfills, handling wastes in remote rural villages, and in beginning to promote recycling within the states. The report presents recommendations to the EPA Region 10 office on ways in which it can assist the states. Emphasis is on market development, basic technical assistance, interstate issues, education and outreach, and research needs. The report is based on over a hundred interviews with states regulators, legislators, local waste managers, governmental and tribal associations, non-profit groups, and waste/recycling industries.

26037 (RCM–CE02982) **Container recycling for Manitoba.** Tomlinson, D. Recycling Council of Manitoba, Winnipeg, MB (Canada). 1988. 54p. (CE–02982). Available from Recycling Council of Manitoba, 1329 Niakwa Road East, Winnipeg, MB, CAN R2J 3T4. Prices: PRICES UPON REQUEST.

The Recycling Council of Manitoba was incorporated in 1985 and is a non-profit group of citizens including representatives of several recycling industries and employees of the city, provincial, and federal governments, who seek to promote the practice of recycling. This report examines some of the ways to alter the wasteful cycle of consumption by affecting disposal and raw materials use of containers used for beverages, particularly beer and soft drinks. The report examines and evaluates the options of centralized separation, curbside pick-up, buy-back centres, deposit legislation, and other government action. Most of the research into markets for recyclable goods concerns the city of Winnipeg, which is the largest market in Manitoba. The report also makes reference to Ontario's municipal recycling support program, as well as programs in British Columbia, Quebec, Alberta, and California. 58 refs., 1 fig., 1 tab.

26038 (SEMR–9) **Energy audit: Prince Albert Recreation Centre; retrofit of recreation facilities project - phase I: Final report.** Saskatchewan Dept. of Energy and Mines, Regina, SK (Canada). [1984]. 54p. (CE–02969). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

On March 11th, 1982 Keen Engineering Co. Ltd. were commissioned by Saskatchewan Mineral Resources to conduct an energy analysis study of the Prince Albert Recreation and Senior Citizens Centre. Results found that the present building energy index of the Recreation and Senior Citizens Centre, at 36 kWhrs/ft^2/yr, is not excessively high for a facility of this type and age. The Recreation Centre is an efficient cube shape, it has minimal glazing and a limited ventilation system. The present energy index of the total complex, including pool heating is 53 kWhrs/ft^2/y. The implementation of the medium cost retrofit option will result in a net annual saving of $4600.00 at a cost of $9250.00 generating a simple payback period of 2 years. The savings in both building and total complex energy comsumption ;amount to 17% of the present consumption, resulting in a building index of 30 kWhrs/ft^2/yr and a complex index of 44 kWhrs/ft^2/yr. 6 figs., 1 tab.

26039 (SEMR–10) **Energy audit: North Battleford Civcic Centre; retrofit of recreation facilities - Phase I: Final report.** Saskatchewan Dept. of Energy and Mines, Regina, SK (Canada). [1984]. 71p. (CE–02970). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

In the Spring of 1982, Saskmont Engineering Company Limited conducted an energy audit of the Civic Centre in North Battleford, Saskatchewan. The results of that audit are summarized herein. The Civic Centre was built in 1961, containing about 49,000 square feet of skating surface, bleachers, recreational and service areas. Three steam heated forced air systems heat most of the building. Summarized are the implementation costs, energy saving, dollar saving and payback period of energy conservaton measures identified in this report. Actual total savings may be less than the sum of the individual returns since some measures diminish the return yielded by others. A great amount of energy can be conserved by modifying the main heating systms. These items are recommended despite the longer payback periods. The strongly recommended measures will yield a first year return of $5,854.81. With a capital expenditure of $23,250 a 35% rate of return will be realized. Some of the energy conservation measures include modifying the lounge arena and lobby ventilation system, aand insulating the rink glazing. 6 figs., 3 tabs.

26040 (SEMR–36) **Retofit: Yorktown Agriplex; retrofit of recreation facilities project - phase II: Final report.** Saskatchewan Dept. of Energy and Mines, Regina, SK (Canada). [1984]. 91p. (CE–02966). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Agriplex was built around 1976 and contains mine separate facility areas and totals 87,519 ft ^{2} in area, these include ice arena, dressing rooms, rampways, concourse, curling arena, indoor pool, convention centre, ice machine, and agripavilion. The building has historically used about 86 Kwhft^2/yr. of energy (37% electricity, 63% gas) and its demand peaks at about 8.9 watt/ft^2. In the fall of 1983 Saskmont Engineering Ltd. was commissioned to implement Phase II of a retrofit on the Yorkton Parkland Agriplex. Final recommendations included: the installing of heat recovery equipment to reclaim chiller waste heat, the installation of destratification focus in the curling rink and an air balance of all HVAC systems.

26041 (SEMR–38) **Retrofit: Swift Current Recreation Centre; retrofit of recreation facilities project - phase II: Final report.** Saskatchewan Dept. of Energy and Mines, Regina, SK (Canada). [1984]. 58p. (CE–02965). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Swift Current Recreation Centre, was built about 1951 as an armories building. in 1968 the armories was taken over by the city of Swift Current and converted to a Recreation Centre. The purpose of this study is generally to conduct a detailed energy analysis of the facility, identify energy losses and propose solutions to these losses. Results from the study showed that the yearly energy usage for this building was actually very low and this was possibly due to the heat sink effect of the massive concrete floor structure and the shooting range extending under the gymnasium. Most changes therfore were relatively minor. The no-cost items and the automatic controls should be carried out as these items are of modest cost and result in excellent energy savings and aid in other reductions in management costs. 15 figs., 2 tabs.

26042 (SEMR–39) **Retrofit: North Battleford Civic Centre: retrofit of recreation project - phase II: Final report.** Saskatchewan Dept. of Energy and Mines, Regina, SK (Canada). [1984]. 63p. (CE–02968). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Civic Centre was built around 1961 and consists of 49,000 square feet of skating surface, bleachers, lobbies and lounges. The ice plant is an ammonia brine system. The building's primary heating is through a steam boiler. Heat is distributed through three air handling systems. The building has historically used about 61 equivalent kWh ft_2/year. In the fall of 1983 Saskmont Engineering Ltd. was commissioned to implement Phase II of a retrofit on the North Battleford Civic Centre. Recommendations show that for a total investment of $49,813 the energy index of the building is predicted to be reduced from 61 to 38 achieving an annual saving of $16,855 and a 3.6 year simple payback. The following measure influence energy use strongly: reflective ceiling insulation, destratification fans, night setback equipment, brine pump controls, lighting and heat recovery. 7 tabs.

3209 Education and Public Relations

Refer also to citation(s) 25656, 25881, 25977, 25982

26043 (CCNB–2001) **The Conserver House project of the Conservation Council of New Brunswick: Final report.** Brown, J. (Conservation Council of New Brunswick, Fredericton, NB (Canada)); Wilson, B.; Lecours, R. Conservation Council of New Brunswick, Fredricton, NB (Canada); Conserver House, Fredricton, NB (Canada). Dec 1984. 23p. (CE–02895). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The paper discusses the demonstration and public awareness value of Conserver House, an old house retrofitted with renewable energy technology, now an information and demonstration centre for residential energy conservation sponsored by the Conservation Counsel of New Brunswick. Participants in workshops, seminars and open houses at Conserver House average 5000 per year. Telephone inquiries were frequent and the library was well utilized. The impact on the community can be witnessed in the significantly increased availablity of conservation products in local hardware stores, and the emergence of conservation companies. It is recommended that a comprehensive study on the social impact of the project be developed; that Conserver House continue to offer the same level of service but with programs tailored for specific groups such as builders or low income homeowners; and that a consumer protection program be implemented allowing for research and advocacy in this area.

33 ADVANCED PROPULSION SYSTEMS

3301 Internal Combustion Engines

Refer also to citation(s) 25688, 26048, 26049

26044 (CONF-8805106–, pp. 188-192) **Controlled combustion engines.** Oppenheim, A.K. (Univ. of California, Berkeley (USA)). Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

Upon harnessing the fire by the early pioneers, the strive for controlled combustion provided the major incentive for progress in engine technology. At first this involved primarily the problem of knock and later that of pollutant emissions. It appears that both can be solved by treating the engine cylinder not only as a source of power but also as a controllable chemical reactor. The principal concept whereby this can be accomplished involves multi-point ignition combined with charge dilution and stratification. Means for this purpose include jet ignition, product recirculation, and chemical additives. The most suitable for the realization of this concept is a direct injection two-stroke engine.

26045 (DOE/AL/42602–T1) **LDA measurements of the flow field and flame visualisation inside an internal combustion engine.** Margary, R. (Fiat Centro Richerche, Turin (Italy)); Nino, E.; Vafidis, C. Imperial Coll. of Science, Technology and Medicine, London (UK). Dept. of Mechanical Engineering. Dec 1989. 15p. Sponsored by U.S. DOE Conservation & Renewable Energy; Joint Research Committee of European Engine Manufacturers. DOE Contract AS04-87AL42602. Order Number DE90009303. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; Imperial College of Science, Technology and Medicine, Department of Mechanical Engineering, Fluids Section, Exhibition Road, London SW7 2BX, UK; GPO Dep.

Measurements of swirl and radial mean and turbulent velocity components are reported, obtained by laser Doppler velocimetry in the disc-type combustion chamber of a four stroke, petrol port-injected, spark-ignition engine, firing at 1000 rpm. The results, supported by cylinder pressure and combustion photography studies, reveal that the initially quiescent pre-flame gas regions are accelerated by the expanding flame front while the post-flame combustion products reverse towards the ignition site, inducing a strong and persistent bulk swirl motion. Turbulence levels ahead of the flame and after the end of combustion were of similar magnitudes to those under motoring conditions. 31 refs., 10 figs., 2 tabs.

26046 Directions in high temperature intermetallics research. Dimiduk, D.M. (Oak Ridge National Laboratory, TN (USA)); Miracle, D.B. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Structural intermetallic materials have undergone an evolutionary process whereby some of the materials could provide major payoffs in gas turbine engines. This maturation of select intermetallic systems has provided significant hope for making still greater advances in turbine performance through further developments in other intermetallic materials. The same maturation process has highlighted specific limitations and requirements which are key to the utilization of intermetallic systems. This paper briefly reviews some critical ground rules for high temperature intermetallics development and identifies research directions being pursued by the Air Force for advancing intermetallic materials. 12 refs.

26047 A simplified sizing and mass model for axial flow turbines. Hudson, S. L. (Sandia National Labs., Albuquerque, NM (USA)). pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). DOE Contract AC04-76DP00789. (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899473.

An axial flow turbine mass model has been developed and used to study axial flow turbines for space power systems. Hydrogen, helium-xenon, hydrogen-water vapor, air, and potassium vapor working fluids have been investigated to date. The impact of construction material, inlet temperature, rotational speed, pressure ratio, and power level on turbine mass and volume has been analyzed. This paper presents the turbine model description and

results of parametric studies showing general design trends characteristic of any axial flow machine. Also, a comparison of axial flow turbine designs using helium-xenon mixtures and potassium vapor working fluids, which are used in Brayton and Rankine space power systems respectively, is presented.

3302 External Combustion Engines

Refer also to citation(s) 26047

3303 Electric-Powered Systems

Refer also to citation(s) 25856

3306 Vehicle Design Factors

26048 (EPM/GI–RTQ-88-01) **Delphi method survey on the penetration of advanced ceramic materials in engine manufacture.** Leblanc, D. (Ecole Polytechnique de Montreal, Montreal, PQ (Canada)); Rigaud, M. Ecole Polytechnique de Montreal, PQ (Canada). Dept. de Genie Industriel. Aug 1988. 60p. (MICROLOG–89-04703). Available from PC Ministere des transports du Quebec, Direction des communications, 700, boul. St-Cyrille Est,, 18e etage, Quebec, PQ, CAN G1R 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

The purpose of this Delphi survey was to identify the main classes of ceramic materials capable of being used in automotive engines to reduce weight and fuel consumption. It also identifies engine parts which can be readily made of ceramic materials, to identify the present and future orientations of research and development in this field, and to assess the future impact of these new materials. The Delphi survey was conducted in March and May 1987 among 48 experts in the USA, in Canada and in Europe. A consensus was reached after 2 rounds. The world consumption of advanced ceramics for the manufacturing of engines is predicted to be about 123,000 tonnes by the year 2,000, mainly silicon nitride and sialons for contact-parts, hot parts and rotors (71,000 tonnes) and zirconium oxide for contact and hot parts (21,000 tonnes), based on an advanced ceramics weight of 2.2 kg/engine. Among the parts which are most likely to be made of ceramics are combustion control sensors and catalytic contact parts (guides, pushers and inserts). The substitution of steels and other metallic alloys with advanced ceramics will begin in Diesel motors; in the year 2,000, the average weight of advanced ceramics should be 4.5 kg per Diesel engine, compared to 1.5 kg per Otto cycle engine. 2 refs., 11 tabs.

26049 (PB–90-858556/XAB) **Fuel injection for internal combustion engines. May 1974-January 1990 (A Bibliography from the NTIS data base). Report for May 1974-January 1990.** . National Technical Information Service, Springfield, VA (USA). Feb 1990. 102p. Available from NTISPC N01/MF N01.

Supersedes PB–85-871580.

This bibliography contains citations concerning research and development of fuel injection systems applied to internal combustion engines and turbines. Gasoline, diesel, synthetic fuels, and liquid gas systems are discussed relative to systems variations and performance. Fuel injection atomization and combustion are considered in theory, and fuel injection relative to emission control is included. (This updated bibliography contains 176 citations, 95 of which are new entries to the previous edition.)

3308 Alternative Fuels

Refer also to citation(s) 25282, 25630, 26002

26050 (AD-A–216013/3/XAB) **US army methanol-fueled administrative vehicle demonstration program. Final report, March 1986-August 1989.** Baber, B.B.; Lestz, S.J.; LePera, M.E. Southwest Research Inst., San Antonio, TX (USA). Belvoir Fuels and Lubricants Research Facility. Aug 1989. 254p. (BFLRF–233). Available from NTIS, PC A12/MF A02.

A methanol-fueled fleet test demonstration program was conducted using administrative-type vehicles to determine the feasibility of using methanol as an alternative fuel. Over 1,026,000 miles were accumulated using 64 administrative-type vehicles. Approximately 750,000 of these miles were accumulated using M85 methanol fuel. Existing engines engineered for use with gasoline and special methanol engines engineered for use with M85 methanol fuel were included in the program. Fuel economy, in miles per gallon, obtained for vehicles using M85 fuel is shown to be approximately one-half that obtained using regular unleaded gasoline. When the costs of M85 fuel and unleaded gasoline are included in economic calculations, it is shown that using M85 increases the fuel cost by a factor of approximately 3.0. No catastrophic engine failure occurred using either fuel. Even though wear rates, indicated from used oil sample analyses, obtained when using M85 fuel appear to be 2 to 4 times those obtained using unleaded gasoline, actual wear, from inspections and measurements, does not appear to be as severe. No significant increase in individual vehicle maintenance, other than increased oil drains, was noted for the methanol vehicles. M85 refueling stations were set up at four fleet test sites, and no significant operational problem, safety or otherwise, was encountered during the program.

26051 (DOE/METC–88/6098, pp. 105-113) **Evaluation of coal derived liquids for locomotive engines.** Chu, C.I.C. (UCC Research Corporation, Bristol, VA (USA)); Miin, T.T.C.; Montafia, S. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The main objectives of this project are to obtain a supply of coal-derived liquids; refine the liquids into a suitable fuel for diesel engines; test the engines with the fuel; and conduct a mobile locomotive demonstration test. This project encompasses six task as described below to accomplish the above stated objectives. Task 1. -Obtain 20,000 gallons of Coalite liquid. This quantity of liquid is estimated to be sufficient for the project study. Coalite liquid, which is produced from Coalite, Ltd., Chesterfield, England, is very similar to the liquid derived from UCCRC's Mild Gasification Process (MGP). This task will also undertake laboratory analysis on the liquid. Task 2. Procure a coal liquid refinery facility and undertake coal liquid processing. Blending of coal-derived diesel with petroleum derived diesel may be conducted, if necessary. Task 3. -Characterization of the fuels produced from Task 2 to assure their quality. An optimum fuel blend for diesel engine testing. Task 4. -Conduct stationary small diesel engine testing using the optimum fuel. Both fuel characteristics and engine performance will be monitored. Task 5. -Conduct stationary locomotive engine testing current design. Task 6. -Conduct a full scale demonstration run of mobile diesel locomotive train.results to date are described. UCCRC has conducted engine tests of the coal diesel developed in a 15 HP, 3 cylinder tractor diesel engine and a coal truck equipped with a 300 HP, 14 speed, Cummins' big cam with turbo engine. No appreciable engine performance difference was observed in using this coal diesel, in comparison with petroleum diesel.

35 ARMS CONTROL

Refer also to citation(s) 25886, 25887, 25888, 25889, 25890, 25891, 25892, 25893, 25894, 25895, 25896, 25897, 25898, 25899, 25900

3501 Policy, Negotiations, and Legislation

Refer also to citation(s) 26562

26052 (UCRL-ID–103133) **Key considerations in the selection of an appropriate response to evidence of a treaty violation.** Lippitz, M.J. Lawrence Livermore National Lab., CA (USA). Mar 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. Order Number DE90007930. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A formal decision analytic framework for assisting in determining how to respond to evidence of treaty violations is described. The nature of violations and the effectiveness of responses are first discussed qualitatively. A mathematical model is then used to suggest potential advantages of responding to evidence of a violation with less than full vigor. When evidence for a violation is not unequivocal, a milder response may serve as a hedge or as the best response to a less serious violation. The analysis legitimates such an intermediate response as a compromise position among policy makers who disagree as to the significance of a transgression. In conclusion, we suggest how the framework can provide proactive guidance to negotiators of arms control treaties by allowing for the design of verification systems consistent with the limits of the negotiated detection systems and the monitoring nation's response options. 25 refs., 9 figs.

3503 Verification

Refer also to citation(s) 26052

26053 (ANL/ACTV–90/1) **Future treaties: Chemical weapons convention.** Gaines, L.L.; Tanzman, E.A. Argonne National Lab., IL (USA). Sep 1989. 63p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-31109-ENG-38. Order Number DE90007949. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The recent use and the proliferation of chemical weapons provide impetus to the ongoing negotiations in Geneva to ban the production, possession, and use of all chemical weapons. The provisions of the Chemical Weapons Convention are not all agreed upon yet, challenge inspections and sanctions against violators being two particularly difficult areas. Verification of declared stocks and activities poses no major technical problems, but care in technology development and selection will be required to provide effective verification with minimum intrusion. A carefully designed system will be needed to interpret the extensive data from routine inspections, monitoring, and reporting and to protect company proprietary information. Identification of appropriate sites for challenge poses very difficult technical problems, on which R&D could be fruitful. On-site inspection in the US poses potential problems ranging from the loss of classified or proprietary information to high financial costs for site preparation and lost operating time. Site access for inspection could also violate US companies' freedom from illegal search and seizure; several remedies are considered. 47 refs., 2 figs., 7 tabs.

36 MATERIALS

26054 (UCRL-JC–103276) **Shock compression of solids: A tutorial.** Nellis, W.J. Lawrence Livermore National Lab., CA (USA). [1990]. 72p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900384–1: American Physical Society meeting, Anaheim, CA (USA), 12-16 Mar 1990). Order Number DE90009185. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The focus of this tutorial will be on fundamentals of shock- compression physics, the states achieved, and laboratory experiments with research-size specimens. Shock pressures can be applied to assemblies of virtually arbitrary size using explosive systems. Hence, results of laboratory shock-compression research can be scaled to industrial quantities as well.

3601 Metals and Alloys

Refer also to citation(s) 25622, 25623, 25671, 25738, 25752, 25753, 25755, 25756, 25757, 25758, 25759, 25760, 25761, 25762, 25763, 25764, 25765, 25766, 25767, 25768, 25769, 25772, 25774, 25787, 25803, 25811, 25823, 25828, 25859, 25935, 26021, 26046, 26196, 26269, 26287, 26289, 26340, 26345, 26408, 26417, 26434, 26533, 27117, 27118, 27119, 27126, 27127, 27128, 27129, 27132, 27133, 27134, 27135, 27219, 27221, 27223, 27337, 27338, 27339, 27381

26055 (CONF-8904275–, pp. 6, Paper 20) **In-situ measurement of ion beam induced deposition of gold.** Dubner, A.D. (Massachusetts Institute of Technology, Cambridge (USA)); Wagner, A. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

A mechanistic model of the ion beam induced deposition, (IBID) process is proposed, and an experimental system for measuring IBID is described. In IBID, the kinetic energy of the incident ion is deposited in the substrate surface resulting in the ejection of atoms (sputtering), and the decomposition of adsorbed molecules. Net deposition occurs when the number of atoms added through decomposition exceeds the number removed by sputtering. Gold films were deposited by decomposing dimethyl gold hexafluoroacetylacetonate ($C_7H_7F_6O_2Au$) molecules with a 5 keV argon ion beam. The beam current density was 5 $\mu A/cm^2$. These films were deposited on quartz crystal microbalances (QCM). The QCM's provide an in-situ measurement of the deposition rate as a function of ion dose, dose rate, gas pressure, and substrate temperature. The mass of the depositing film increases with increasing ion dose. The deposition yield, or mass deposited per incident ion, is independent of the power input of the ion beam and therefore, the decomposition is not due to macroscopic heating. The deposition yield is shown to depend on the sputter yield of the substrate. The yield increases with increasing gas pressure and decreasing substrate temperature. This increase is proportional to the adsorption of the organometallic gas. 9 refs., 4 figs.

26056 (CONF-8904275–, pp. 6, Paper 50) **The study of boron implantation in 1:7 Nd/Fe multilayers.** Guoan Cheng (Jiangxi Univ., Nanchang (China)); Yingguo Peng. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The structures and magnetic characteristics of multilayered samples with alternatively deposited metal layers (Nd and Fe) were studied for 80 keV boron ion implantation to various doses. Boron ion implantation induced amorphization in Nd/Fe multilayers gradually with increasing irradiation dose. The hysteresis loops of magnetization of the samples showed that a sunken curve appeared in the second and fourth quadrants of the loops for the deposited Nd/Fe films and disappeared when implantation dose was more than $4^* 10^{16}$ B^+/cm^2. During ion irradiation, the coercive forces of the films were decreased. The saturation magnetization and the residual magnetization decreased first and then increased with increasing ion dose, the squareness ratio S.R. increased first and then decreased. Discussion was carried out in this paper. 12 refs., 2 figs., 3 tabs.

26057 (CONF-8904275–, pp. 9, Paper 27) **Partially ionized beam deposition of thin films.** Lu, T.M. (Rensselaer Polytechnic Institute, Troy, NY (USA)). Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

It has been shown recently that using less than a few percent of self-ions, i.e., ions derived from the deposition material itself, (partially ionized beam (PIB) deposition), one can dramatically modify thin film properties. In this paper the authors discusses phenomena such as surface cleaning, enhanced surface ordering, and ion-induced surface damage associated with PIB-surface interactions. PIB metal deposition has been emphasized. 32 refs., 5 figs.

26058 (DOE/ER/01198–T42) **Heavy-ion damage in Cu, Ni and dilute Ni alloys.** Vetrano, J.S. Illinois Univ., Urbana, IL (USA). [1990]. 130p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER01198. Order Number DE90009364. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

Though it has long been appreciated that materials differ in their response to heavy-ion irradiation, the reasons for this are not yet fully understood. To more fully characterize the effects of material, alloying element, irradiation temperature and ion dose on the probability of collapse of a displacement cascade, Cu, Ni, and dilute Ni

alloys (Ni–Si and Ni–Al) have been irradiated with 50 and 100 keV heavy-ions (Kr^+ and Ni^+) at both 30 and 300K, and to doses ranging from 10^{15}–10^{17} ions m^{-2}. The irradiations resulted in the formation of vacancy dislocation loops which were examined in a transmission electron microscope (TEM) and characterized by their size, Burgers vector, and formation probability. For some of the irradiations, the HVEM-Accelerator Facility at Argonne National Laboratory was used. This facility is unique in that it allows irradiation and microstructural examination to be performed at temperatures where there is no long-range point defect mobility, and the examination of the same area of sample at different dose levels. 89 refs., 32 figs., 9 tabs.

26059 (DOE/ER/45327–2) **Controlled production and characterization of metastable intermetallics: Final report, August 1, 1987–December 31, 1989.** Kaufman, M.J. Washington Univ., Seattle, WA (USA). Dept. of Materials Science and Engineering. Mar 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-87ER45327. Order Number DE90009384. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this investigation was to establish whether or not it is possible to produce metastable intermetallics as bulk single phase materials and, if possible, to characterize the properties of these phases accordingly. The Al–Ge system was selected as the prototype for this study because of the relative ease with which metastable phases are formed in this system. In addition, the Ti–Al and Ti–Al–Nb systems were also studied based on the controversial nature of their stable and metastable phase equilibria as well as the greater technological significance. The results from all three systems will be described below. Finally, a brief examination of the Al_3X compounds (X = Ti, Hf and Zr) was initiated but discontinued when our preliminary results, and those of other investigators, indicated that these materials were not responding favorably to either stable or metastable processing. 7 figs., 1 tab.

26060 (ENEA-RT-TIB–89-23) **Critical analysis of localized corrosion behaviour of materials of energy interest (Inconel 600 and Deltacogne PWR steam generator tubes).** Borello, Alberto; Frangini, S.; Masci, D. ENEA, Casaccia (Italy). Dipt. Tecnologie Intersettoriali di Base. Jul 1989. 43p. (In Italian). (RT/TIB–89-23). Order Number DE90764337. Available from NTIS (US Sales Only), PC A03/MF A01.

Concerning the two commonly observed phenomena of localized corrosion in Inconel 600 tubing in high temperature caustic environments normally encountered in steam generators of PWR nuclear reactors, the aim of this work was to investigatethe intergranular and stress corrosion cracking behaviour of two casts of Alloy 600, having different origin. In fact one cast was produced by Centro Sviluppo Materiali (CSM) in laboratory scale; the other one was manufactured by Deltaco gne following conventional industrial practices. The evaluation of intergranular corrosion susceptibility was performed by means of the modified Huey test and Electrochemical Potentiokinetic Reactivation (EPR). The stress corrosion cracking susceptibility was determined by the slow strain rate technique. The results of the present study showed that the CSM cast has a better behaviour than the Deltacogne one as regards stress corrosion cracking susceptibility. On the contrary, concerning the intergranular corrosion resistance, both tests pointed out that the Deltacogne material has a lower susceptibility to this type of localized corrosion. The sensitization areas in the TTS diagram, depend, even for the same cast, on the type of the test used for the evaluation.

26061 (FhG-IWM-W–2/89) **Finite element method for the simulation of impact tests on large-size bending test specimens of a pressure vessel steel.** Vo, T.; Stoeckl, H. Fraunhofer-Institut fuer Werkstoffmechanik, Freiburg im Breisgau (Germany, F.R.). May 1989. 40p. (In German). Contract BMFT 150 0488 A. Available from Copy held by UB/TIB Hannover.

Impact tests have been made on 3-point bending test specimens of the size 495x90x45 mm^3 of a pressure vessel steel in order to verify the experimentally determined J-integral and the crack propagation Δa by the numerical finite element method. The model uses the impact hammer as the point mass, the contact area as the elastic spring, and the specimen as a two-dimensional FE model, and assumes a plane stress. The calculations have been made with explicit time integration, taking into account dynamic effects. The measured time curve of the hammer load in the initial phase could not be reproduced with the statically determined elastic-plastic stress-strain relation. Modelling is achievable assuming a viscoplastic material model with a fluid parameter $\gamma = 100$ s^{-1}. With a strong entire deformation of the specimen being given, the measured hammer impact could be explained assuming a friction with a friction coefficient of 0.7. About 10 to 15% of the hammer impact energy is taken up at the bearing points, and considering this percentage, the experimental data and the numerically derived $J(\Delta\alpha)$ curve almost agree. After about 5 mm of crack propagation, the calculated J-integral increasingly depends on the integration area. This is assumed to be due to the fact that the energy density becomes explicitly dependent on position as a result of relieving processes. (orig.).

26062 (FhG-IWM-W–4/89) **Numeric and experimental studies on surface cracking of disks and pipes of ferritic and austenitic steels.** Memhard, D.; Klemm, W. Fraunhofer-Institut fuer Werkstoffmechanik, Freiburg im Breisgau (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Sep 1989. 80p. (In German). Contract BMFT 150 0488 A. Order Number DE90767263. Available from NTIS (US Sales Only), PC A05/MF A01.

For safeguarding the transmission chain from the two-dimensional sample to real three-dimensional structural components, the behavior of surface cracks in disks and pipes was investigated in an experimental and a theoretic-numerical way. The objective was a quantitative failure analysis which covers essential phases resulting from operation and breakdown conditions, in fact from the first propagation of the incipient crack under fatigue loading to stabile crack growth under monotonously increasing load up to wall breakthrough and a possible subsequent instability. The investigations of the growth of fatigue cracks show that the growth of partial through-cracks in disks and pipes is generally overestimated in analytic calculations, if the constants of the crack propagation determined for CT samples are used for these calculations. The results presented here show that the J-integral concept is suited to give a good description of the behavior of cracks in constructional components under shear fracture conditions as to the quality and quantity, if the influence of the multi-axiality of the state of stress on the resistance against crack propagation is appropriately considered. The transferability of samples to constructional components seems to be possible for purely mechanical strain even with a superposed amount of bending for a crack propagation which is not too great. (orig.).

26063 (FhG-IWM-W–6/88) **Analysis and development of fracture-mechanical failure concepts, with particular regard to further development and validation of the concept. Final report.** Schmitt, W. Fraunhofer-Institut fuer Werkstoffmechanik, Freiburg im Breisgau (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Feb 1989. 90p. (In German). Contract BMFT 1500 488 A. Order Number DE90767254. Available from NTIS (US Sales Only), PC A05/MF A01.

In the framework of this research project, the influence of the parameters (a) crack and component geometry and (b) crack propagation was studied. For this purpose, the behaviour of surface cracks in tensile test disks and pipes was analyzed under ductile-fracture conditions on the one hand, and on the other hand, dynamic crack resistance curves in the upper shelf viscosity were determined. Further studies which, however, did not surpass a first orientation phase were concerned with the verification of the J integral concept in the case of superposed stress (thermomechanical, tension/shear). (MM).

26064 (FhG-IWM-W–10/89) **Applications and limits of probabilistic models in reliability analyses of industrial facilities. Final report.** Memhard, D.; Stoeckl, H.; Voss, B. Fraunhofer-Institut fuer Werkstoffmechanik, Freiburg im Breisgau (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Jul 1989. 67p. (In German). Contract BMFT 1500 637 B. Order Number DE90767241. Available from NTIS (US Sales Only), PC A04/MF A01.

Analytic and numeric methods which consider local, microstructural material properties (local approach) are indispensable in order

to provide sufficiently reliable statements on the scattering of fracture-mechanical parameters for probabilistic models. Such models are available for the cleavage in the depth (weakest link model) and for the ductile fracture (for example the Gurson model). Experimental and numeric tests for the reactor pressure vessel steel 20 MnMoNi 55 (1.6310) were made in the depth of toughness. Fracture-mechanical tests were mainly made at nitrogen temperature and analyzed statistically, fractographically and metallographically. Numeric simulation calculations according to the method of the finite elements with different fine-mesh nets were carried out for a selected experiment. Fracture probabilities on the basis of the weakest link model (Weibull model) were calculated from the stress distributions computed and compared with the experimental data. Due to the small plastic zones, very fine nets are necessary for the investigated extreme depth range in order to obtain a good accordance with the experimentally determined failure loads (deviation below 10%) and other scatterings. (orig./HP).

26065 (FTC–E62522C-Vol.1) **Evaluation of heat affected zone and weld metal toughness in selected steels (Phase 2): Submerged arc welding program: Final report, vol.1.** Chiu, C.; Malik, L. Fleet Technology Ltd., Kanata, ON (Canada). Mar 1989. 209p. Contract EMR 06SQ.23440-4-9056-1. (MICROLOG–89-06203). Available from PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The severe environmental conditions found in Canada Arctic and offshore applications place stringent demands on toughness of structural steels. A series of studies was conducted to evaluate low temperature toughness in the heat affected zone of C-Mn structural steel plate. A series of submerged arc welds was prepared using two different wire-flux combinations giving weld metals alloyed with Ti-B and Mo respectively. Procedural variables such as heat input, post weld heat treatment, interpass temperature and joint restraint were systematically changed, and their effect on weld metal toghness assessed. The results showed that the Ti-B weld metal had excellent Charpy and crack tip openting displacement (CTOD) toughness which changed marginally with the variables studied in the program. This excellent toughness, and insensitivity to welding procedural variables is attributed to: reduced susceptibility to strain aging damage on account of low total and free nitrogen content; presence of boron which suppresses the formation of grain boundary ferrite, and facilitates formation of acicular ferrite; and inclusions which contain Ti, and presumbaly have an optimum size distribution to nucleate acicular ferrite. In comparison, the Mo-containing welded metal had relativley inferior toughness caused primarily by its higher nitrogen content, and smaller unbalance factor, its higher hardness, and higher number density of inclusions greater than 1μm. It has also been demonstrated that changes in the macrostructure distribution at the notch of a Charpy vertical notch specimen can lead to substantial changes in the transition temperature - larger than those due to procedural variables. 24 refs., 116 figs., 47 tabs.

26066 (FTC–E62522C-Vol.2) **Evaluation of heat affected zone and weld metal toughness in selected steels (phase 2): Gas metal arc welding program: Final report, vol.2.** Chiu, C.; Malik, L. Fleet Technology Ltd., Kanata, ON (Canada). Mar 1989. 116p. Contract EMR 06SQ.23440-4-9056-1. (MICROLOG–89-06203). Available from PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The severe environmental conditions found in Canada Arctic and offshore applications place stringent demands on toughness of structural steels. A series of studies was conducted to evaluate low temperature toughness in the heat affected zone of C-Mn structural steel plate. Four gas metal arc welds have been prepared using Argon-5% carbon dioxide shielding gas and three consumable wires giving weld deposits alloyed with Mn-Mo, Mn-Si, and Ti-B respectively. All welds were made at 3.0 kJ/mm heat input, and the one with Ti-B weld metal was examined in the stress relieved condition also. The Charpy and crack tip opening displacement toughness of the weld deposits, in comparison to that at 1.7 kJ/mm in another study, has been qualitatively explained in terms of their composition, strength, microstructure and inclusion distributions. The Ti-B weld deposits had the best toughness on account of their low nitrogen content, and the ability to retain relatively high amount of acicular ferrite at the high input used in the progam. The Mn-Mo deposit also retained its excellent microstructure with large proportion of acicular ferrite; however, its higher hardness and nitrogen content are believed to have led to its mediocre toughness. It is anticipated that a stress relief heat treatment would considerably enhance the deposit toughness. The Mn-Si deposit suffered considerable reduction in toughness due primarily to its low hardenability leading to considerable reduction in acicular ferrite content and coarsening of the microstructure. 5 refs., 47 figs., 30 tabs.

26067 (FTC–E62522C-Vol.3) **Evaluation of heat affected zone and weld metal toughness in selected steels (Phase 2): Flux coned arc welding program: Final report, vol.3.** Chiu, C.; Malik, L. Fleet Technology Ltd., Kanata, ON (Canada). Mar 1989. 240p. Contract EMR 06SQ.23440-4-9056-1. (MICROLOG–89-06203). Available from PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The severe environmental conditions found in Canadian Arctic and offshore applications place stringent demands on toughness of structural steels. A series of studies was conducted to evaluate low temperature toughness in the heat affected zone of C-Mn structural steel plate. A series of 14 welded assemblies were prepared using the gas shielded flux cored arc welding process, with the objective of examining the effect of welding procedural variables on weld metal toughness. All the welds were made using one of 3 different commercially available consumables and Ar-25% CO_2 gas shielding. Variables studied included heat input, post weld heat treatment, welding position, and lateral joint restraint, and their influence was assessed by microstructure charcaterization, deposit composition, Charpy vertical notch (CVN) and crack tip opening displacement (CTOD) toughness. The results indicate that better toughness is achieved at lower heat input, and that both higher heat input and stress relief heat treatment lead to deterioration in toughness. One exception to this general observation was the CTOD toughness of stress relieved welds made in the 3G position. These had better toughness CTOD than the corresponding gas-welded joints. Welds in the vertical up postion had better toughness than similar welds in the flat position. These observations are qualitatively related to changes in weld metal composition and microstructure. Single vee welds made with high lateral joint restraint had better CVN toughness, and better root region CTOD toughness as assessed by surface notched specimens. In this study, the single vee welds had better CVN and CTOD toughness, however the precise reasons for this were not clear. 24 refs., 134 figs., 59 tabs.

26068 (GKSS–89/E/46) **Neutron diffraction texture analysis of multi-phase systems.** Brokmeier, H.G. (Technische Univ. Clausthal, Clausthal-Zellerfeld (Germany, F.R.). Inst. fuer Metallkunde und Metallphysik). GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.); Deutsche Forschungsgemeinschaft, Bonn (Germany, F.R.). 1989. 24p. Contract BMFT 3BU1CLA9;DFG Br961/1-1. Available from Reprint from Textures and Microstructures, 1989, v. 10 p. 325-346.

Neutron diffraction methods for texture analysis are closely parallel to well-known X-ray diffraction techniques. The chief advantage of neutron diffraction over X-ray diffraction, however, arises from the fact that the interaction of neutrons with matter is relatively weak, and consequently the penetration depth of neutrons is 10^2-10^3 times larger than that of X-rays. Hence neutron diffraction is an efficient tool for measuring textures in multi-phase systems. Based on the high transmission of a neutron beam the effect of anisotropic absorption in multi-phase materials can be neglected in most cases. Moreover, the analysis of bulk textures becomes possible, such that textures in a wide variety of multi-phase systems

can be studied which are of special interest in engineering and science (metals, alloys, composites, ceramics and geological specimens). (orig.).

26069 (IC–89/376) **Corporative and coherent effect of Martensite transformation.** Zou Jian. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 12p. Order Number DE90622815. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The martensite transformation is studied in this article using the Landau theory. The whole transformation material including martensite and residual austenite is considered. We conclude that the transformation temperature Ms, its variation versus the carbon concentration and the T-dependence of the fraction of martensite formed x. In our model there is no energy barrier problem. The results are consistent with the experiment. (author). 9 refs, 2 figs.

26070 (Juel–2298) **Accumulation of creep damage in X10NiCrAlTi 32 20 (alloy 800 H) in test with stress or temperature changes.** Buchmann, E.; Ennis, P.J.; Schuster, H.; Nickel, H. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Reaktorwerkstoffe; Technische Hochschule Aachen (Germany, F.R.). Aug 1989. 164p. (In German). Order Number DE90767358. Available from NTIS (US Sales Only), PC A08/MF A01.

Dissertation submitted by E. Buchmann.

The applicability of damage accumulation rules and of a constitutive equation derived by Cords to the description of the creep behaviour of X10NiCrAlTi 32 20 (Alloy 800 H) in creep tests with stress or temperature changes has been investigated. The tests were carried out at 800deg C and 900deg C and in order to ensure that the creep damage in the tests was the same as that obtained during actual service, creep tests for durations of up to 10 000 h were carried out. Metallographic examination of tested specimens showed that typical creep damage was occurring under the selected test conditions. It was shown that thermally aged specimens exhibited with increasing ageing time a decrease in time to rupture. Therefore the use of the linear damage accumulation rules for predicting rupture time is only possible if large margins of safety are introduced or if the structural changes due to thermal ageing effects during the creep test are included. Investigations into the applicability of the non-linear damage accumulation model developed by Kachanov were carried out, using different methods for the determination of the necessary materials parameters. By the introduction of a logarithmic time scale for the fitting of all the measured strain/time data at a given temperature, the best prediction of rupture life was obtained. Evaluation of the test results using the Cords set of equations showed that the equations needed to be extended to include an additional damage term at the low stresses of the experiments. (orig.).

26071 (Juel-Conf–77, pp. 207-219) **Influence of sintering and thermomechanical treatment on microstructure and properties of W-Ni-Fe alloys.** Mitkov, M. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)); Kaysser, W.A. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

The 90W-7Ni-3Fe alloys were prepared from fine metal powders by liquid phase sintering at 1470deg C in flowing dry hydrogen. The powders had mean particle sizes of 1,5 μm [W], 5 μm [Ni] and 3 μm [Fe]. The sintered samples were cold rolled to give height reductions of 5, 15 and 50% and rotation forged with the volume reduction of 25%. Subsequently the samples were liquid phase sintered at 1470deg C. Another set of samples were sintered after deformation in the solid state region at 1420deg C. The deformation of individual grains was measured. The distribution of the dislocation densities in individual grains was calculated from shape and size of grains which formed during annealing of the worked samples in solid or partially liquid state. Dislocation densities of up to 10^{15} m^{-2} were deduced right in the vicinity of contact areas of adjacent W grains even after only a slight macroscopic deformation of the material by 5%. At higher degrees of deformation recrystallization of deformed initial W grains and their subsequent disintegration by the penetration of liquid phase lead to considerable grain refinement. The mechanisms of recrystallization, stress induced boundary migration and melt penetration into the recrystallized fine grained materials are discussed. (orig./MM).

26072 (Juel-Conf–77, pp. 237-250) **Early stages of mechanical alloying in Ni-Ti and Ni-Al powder mixtures.** Stubicar, M. (Zagreb Univ. (Yugoslavia). Zavod za Fiziku); Duzevic, D. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

The high energy ball milling technique has been found recently to yield a wide variety of amorphous alloy powders, many of which could not be obtained before by the rapid solidification technique. It is important to know how amorphization by mechanical alloying is influenced by the milling regimes. In our experiments we use a rotating ball mill with centrifugal acceleration reaching to near 10 g value and the normal air atmosphere. As a precursor a powder mixture of the stochiometry Ni_2Ti of the well explored system Ni-Ti was chosen. The main interest is concentrated on the system Ni-Al with the stochiometry of Ni_3Al_2. In the range of 100 h milling time complete amorphization apparently did not occur, either in Ni-Ti or in the Ni-Al system. Nevertheless, a considerable degree of amorphization was accompanied by marked phase changes in both systems as observed by X-ray powder diffraction. (orig./MM).

26073 (Juel-Conf–77, pp. 427-445) **Electrodeposition of titanium from molten salts.** Popov, B. (Skopje Univ. (Yugoslavia). Tehnolosko-Metalurski Fakultet); Koneska, Z.; Wagner, J.B. Jr.; Wendt, H. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

The thermodynamic properties of titanium(II) and titanium(III) species as reduction of titanium(II) and titanium(III) in molten LiCl-KCl eutectic was studied. The work covers: Determination of the oxidation and reduction potential values of the various titanium species in LiCl-KCl, the equilibrium between the solution and the metal (scrap Ti and TiC), as well as studies of oxidation/reduction processes taking place in the melt, when Ti scrap anode is used in the presence of Ti(II) and Ti(III) electroactive species. The apparent valency of the metal ion in the melt immediately after the anodic dissolution was determined by Faraday's low. It was also studied the rate of the corrosion reaction: $2\ Ti(III) + Ti \rightarrow 3\ Ti(II)$ and it has been determined its activation energy. (orig./MM).

26074 (Juel-Conf–77, pp. 491-498) **Optimization of the Na-Tl system.** Novakovic, R. (Srpska Akademija Nauka i Umetnosti, Belgrade (Yugoslavia). Dept. of Technical Science); Ristic, M.M.; Ghosh, G.; Lukas, H.L. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

The liquid phase, the hcp and the bcc solid solution of Tl are described by Redlich Kister polynomials with three terms for enthalpy and entropy each. For the phase NaTl the Wagner Schottky model is chosen with antistructure atoms on the Na as well as on the Tl sublattice. The remaining phases, Na_6Tl, Na_2Tl and $NaTl_2$, are treated as stoichiometric phases. To adjust the parameters of these thermodynamic descriptions experimental values from the literature were used: Phase diagram values (liquidus temperatures, three

phase equilibrium temperatures, and solubility limits of the phase NaTl), enthalpies of mixing of the liquid and partial Gibbs energies of Na in the liquid. The calculation had to be done in several steps. The selection of these steps is described in detail. The resulting description is compared with the input experimental values, the agreement is good. A modern method in assessing phase diagrams is the thermodynamic optimization by computer. Here the application on the Na-Tl binary system is described. (orig./MM).

26075 (Juel-Conf-77, pp. 415-425) **Electrodeposition of metals and metal oxides from molten salts.** Popov, B. (Skopje Univ. (Yugoslavia). Tehnolosko-Metalurski Fakultet). Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325--: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

This paper discusses the following subjects: Electrochemical reduction of (a) molybdenum(III) compounds (K_3MoCl_6), (b) molybdenum(VII) compounds (MoO_3), (c) indium(III) compounds, and (d) chromate (K_2CrO_4) in the presence of $NiCl_2$, all of them in LiCl-KCl eutectic melts. (MM).

26076 (KAERI/RR-722-3/88) **Modeling of container failure and radionuclide release from a geologic nuclear waste repository.** Kim, Chang Lak (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Kim, Jhin Wung; Choi, Kwang Sub; Cho, Chan Hee. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Feb 1989. 104p. (In Korean). Order Number DE90622831. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

Generally, two processes are involved in leaching and dissolution; (1) chemical reactions and (2) mass transfer by diffusion. The chemical reaction controls the dissolution rates only during the early stage of exposure to groundwater. The exterior-field mass transfer may control the long-term dissolution rates from the waste solid in a geologic repository. Masstransfer analyses rely on detailed and careful application of the governing equations that describe the mechanistic processes of transport of material between and within phases. We develop analytical models to predict the radionuclide release rate into the groundwater with five different approaches: a measurement-based model, a diffusion model, a kinetics model, a diffusion-and-kinetics model, and a modified diffusion model. We also collected experimental leaching data for a partial validation of the radionuclide release model based on the mass transfer theory. Among various types of corrosions, pitting is the most significant because of its rapid growth. The failure time of the waste container, which also can be interpreted as the containment time, is a milestone of the performance of a repository. We develop analytical models to predict the pit growth rate on the container surface with three different approaches: an experimental method, a statistical method, and a mathematical method based on the diffusion theory. (Author).

26077 (LA-11558-T) **Strengthening mechanisms of tungsten powder reinforced uranium.** Krawiczki, M.A. Los Alamos National Lab., NM (USA). c Apr 1990. 64p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90009331. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Tungsten powder reinforced uranium composites exhibit a threefold increase in yield strength due to precipitation hardening. The tungsten-rich interphase precipitates form at the moving beta to alpha phase boundary during slow cooling. Further increases in yield strength, attained with increasing tungsten content, are due to composite strengthening. The composite strengthening is verified by increasing elastic modulus with increasing tungsten content. Age hardening behavior is observed, with strengthening occurring at aging temperatures low, in the alpha phase. Temperatures higher in alpha give initial strengthening followed by rapid overaging. Beta phase aging temperatures result in a very soft structure with interphase precipitates observable optically. Wrought material exhibits significant strain hardening as well as composite strengthening due to elongation of the tungsten particles. 36 refs., 36 figs., 10 tabs.

26078 (LA-UR-90-965) **Rotationally anisotropic second-harmonic generation studies of the structure and electronic properties of bimetallic interfaces, Ag on Cu(110).** Hoffbauer, M.A.; McVeigh, V.J. Los Alamos National Lab., NM (USA). [1990]. 11p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900140--17: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 15-19 Jan 1990). Order Number DE90008924. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Rotationally anisotropic surface second-harmonic generation (SHG) has been measured from a clean, well-ordered Cu(110) single-crystal surface as a function of both surface temperature and Ag coverage. For the clean Cu(110) surface, the temperature dependence of the SH response at a fixed azimuthal angle can be correlated with a surface phase transformation. A large decrease in the rotationally anisotropic SH response as a function of surface temperature can be related to changes in the surface disorder. The results are compared with other studies of Cu(110) surface structure using both x-ray and He-atom scattering. The rotationally anisotropic SH response has also been measured as a function of Ag coverage with the Cu(110) surface temperature fixed at 300 K. The results closely follow the formation of an ordered Ag(111)-like overlayer, the nucleation of three-dimensional Ag nanoclusters (<20 Å thick) that enhance the anisotropic SH response, and the subsequent growth of a ~10 monolayer thick Ag film. Variations in the rotationally anisotropic SH response as a function of Ag coverage are used to separate the resonant surface electronic contributions to the nonlinear susceptibility of the interface. 22 refs., 4 figs.

26079 (LA-UR-90-1113) **Model and simulations of hysteresis in magnetic cores.** Boley, C.D. (Lawrence Livermore National Lab., CA (USA)); Hodgdon, M.L. Los Alamos National Lab., NM (USA). [1989]. 18p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36;W-7405-ENG-48. (CONF-8904329--1: 1989 intermag conference, Washington, DC (USA), Apr 1989). Order Number DE90008967. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Using a theory of ferromagnetic hysteresis developed recently, we present simulations of the behavior of a ferrite core connected in series with an initially charged capacitor. Results are given for three materials and are shown to compare favorably with experiment. 5 refs., 10 figs., 3 tabs.

26080 (LBL-26274) **High voltage/high resolution studies of metal and semiconductor interfaces.** Westmacott, K.H.; Dahmen, U. Lawrence Berkeley Lab., CA (USA). Nov 1989. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8910380--1: Symposium on electron microscopy in plasticity, Holzhau (German Democratic Republic), 8-13 Oct 1989). Order Number DE90009065. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The application of high resolution transmission electron microscopy to the study of homo- or hetero-phase interface structures requires specimens that meet stringent criteria. In some systems the necessary geometric imaging conditions are established naturally, thus greatly simplifying the analysis. This is illustrated for a diamond-hexagonal/diamond-cubic interface in deformed silicon, a $\Sigma 99$ tilt boundary in a pure aluminum bicrystal, and a germanium precipitate in an aluminum matrix. 13 refs., 5 figs.

26081 (ORNL/TM-11378) **Selection of support structure materials for irradiation experiments in the HFIR [High Flux Isotope Reactor] at temperatures up to 500°C.** Farrell, K.; Longest, A.W. Oak Ridge National Lab., TN (USA). Jan 1990. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010228. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The key factor in the design of capsules for irradiation of test specimens in the High Flux Isotope Reactor at preselected temperatures up to 500°C utilizing nuclear heating is a narrow gas-filled gap which surrounds the specimens and controls the transfer of

heat from the specimens through the wall of a containment tube to the reactor cooling water. Maintenance of this gap to close tolerances is dependent on the characteristics of the materials used to support the specimens and isolate them from the water. These support structure materials must have low nuclear heating rates, high thermal conductivities, and good dimensional stabilities under irradiation. These conditions are satisfied by certain aluminum alloys. One of these alloys, a powder metallurgy product containing a fine dispersion of aluminum oxide, is no longer manufactured. A new alloys of this type, with the trade name DISPAL, is determined to be a suitable substitute. 23 refs., 13 figs., 3 tabs.

26082 (ORNL/TM–11440) **Metallurgical investigation of material from chill-water piping system.** Alexander, D.J. Oak Ridge National Lab., TN (USA). Feb 1990. 17p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC05-84OR21400. Order Number DE90007973. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The mechanical properties and microstructures of two steel pipes that were removed from the Oak Ridge National Laboratory (ORNL) chill-water system have been studied. Concerns for low-stress failure of aging pipes prompted a metallurgical investigation to determine the risk of using a cryogenic freeze-plug technique to isolate a section of piping for repair. The two pipes, designated S and L, were low-alloy carbon steel, with microstructures of ferrite and pearlite. Pipe S had a small grain size and a banded microstructure, whereas pipe L had a larger grain size with less pearlite, which was randomly spaced. Pipe S had a ductile-to-brittle transition temperature (DBTT) of 0°C, compared to 84°C for pipe L. Because of the high transition temperature and the very low level of the lower shelf, cooling to liquid-nitrogen temperature resulted in a very small margin of safety for these pipes. Therefore, this technique is not recommended for the pipe materials, and caution is advised in applying this technique to any pipe with unknown toughness properties. 8 figs., 2 tabs.

26083 (PB–90-155359/XAB) **Institute for Materials Science and Engineering, Fracture and Deformation division: Technical activities 1989.** McHenry, H.I. National Inst. of Standards and Technology (IMSE), Boulder, CO (USA). Fracture and Deformation Div. Dec 1989. 84p. (NISTIR–89/4149). Available from NTIS, PC A05/MF A01.

See also report for 1988, PB–89-148399.

The report describes the 1989 fiscal year programs of the Materials Reliability Division of the Institute for Materials Science and Engineering. It summarizes the principal accomplishments in three general research areas: materials performance, properties, and processing. The Fracture Mechanics, Fracture Physics, Nondestructive Evaluation, and Composite Materials groups work together to detect damage in metals and composite materials and to assess the significance of the damage with respect to service performance. The Cryogenic Materials and Physical Properties groups investigate the behavior of materials at low temperature and measure and model the physical properties of advanced materials, including composites, ceramics and the new high-critical-temperature superconductors. The Welding and Thermomechanical Processing groups investigate the nonequilibrium metallurgical changes that occur during processing and affect the quality, microstructure, properties and performance of metals. The report lists the division's professional staff, their research areas, publications, leadership in professional societies, and collaboration in research programs with industries and universities.

26084 (PNL-SA–17601) **Grain boundary chemistry effects on irradiation-assisted stress corrosion cracking.** Bruemmer, S.M.; Charlot, L.A.; Simonen, E.P. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 12p. Sponsored by U.S. DOE Energy Research; Electric Power Research Institute. DOE Contract AC06-76RL01830. (CONF-900403–9: NACE Corrosion '90, Las Vegas, NV (USA), 23-27 Apr 1990). Order Number DE90008623. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Radiation-induced segregation (RIS) to grain boundaries and interfacial microchemistry effects on intergranular stress corrosion cracking (IGSCC) has been investigated in 304 and 316 stainless steels (SS). Irradiation dose effects on RIS to grain boundaries were studied using nickel ion bombardment of fine-grained, sputter-deposited SS. Grain boundary chemistry effects on the intergranular (IG) corrosion and stress corrosion cracking (SCC) were examined by varying phosphorus segregation and chromium depletion through controlled thermal treatments. Grain boundary enrichment of phosphorus was found to promote IG corrosion, but not SCC, of 316 SS in low-temperature, sulfuric acid solutions at transpassive potentials. 29 refs., 8 figs.

26085 (RFP–4256) **The effects of a nearby subsequent fusion weld on the properties of an inertia friction weld.** Tsang, S.; Yashan, D.; Kneale, P.A.; Lawton, B.B. Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant. 31 Dec 1989. 24p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-90DP62349. Order Number DE90007972. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Effects of performing a subsequent fusion weld were evaluated. This case involved a defocused electron beam weld near the interface of an inertia friction weld between 1100F aluminum and Type 316 stainless steel. The primary methods of evaluation were metallography and measuring the tensile strength change of the inertia friction weld before and after performing the fusion weld in the proximity of this friction weld. When tensile tested, the friction welds fractured in the 1100F aluminum base metal. Strength degradation, referred to as the electron beam weld damage, was mainly due to softening of the aluminum base metal in and around the heat-affected zone of the friction weld. This softening effect was due to grain growth, which resulted from the heat cycle of the electron beam weld as determined by the weld parameters. Other possible effects on the extent of the damage are steel mating surface geometry and temper of the 1100F aluminum, both of which appear to influence the grain growth process. 3 refs., 12 figs., 1 tab.

26086 (SAND–89-1576C) **Fatigue crack growth from narrow-band Gaussian spectrum loading in 6063 aluminum alloy.** Veers, P.S.; Van Den Avyle, J.A. Sandia National Labs., Albuquerque, NM (USA). [1990]. 42p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004164–1: 1. symposium on advances in fatigue lifetime predictive techniques, San Francisco, CA (USA), 25 Apr 1990). Order Number DE90008957. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Constant amplitude and narrow-band Gaussian loadings are applied to extruded 6063 aluminum crack-growth specimens in an effort to characterize the effective stress intensity levels during random loading. Crack-growth rates are determined for constant amplitude loadings at stress ratios (R) of 0.09, 0.3 and 0.5, and for a variable amplitude loading simulated to match a narrow-band Gaussian spectrum. Crack-opening stress levels measured by the compliance method during the constant amplitude loading are found to differ substantially for -T5 and -T6 heat treatments due to a change from intergranular to transgranular crack growth. Crack-opening load ratios correlate well with the maximum applied stress intensity factor, K_{max}, for the -T5 material. The K_{max} dependence leads to an effective halving of the crack-growth exponent. Calculated variable amplitude lives are much shorter when this correlation is taken into account (an acceleration effect) and show a greater difference between loading blocks condensed by racetrack filtering at threshold levels of two and four standard deviations, similar to what was observed in the tests. Crack-opening-load measurements in one specimen with the narrow-band Gaussian (variable amplitude) loading failed to detect any closure. A substantial difference in the closure behavior of nominally identical R = .3 tests indicates that closure may occur irregularly in the extruded aluminum. Calculated crack-growth lives, assuming no closure in the variable amplitude tests, are much shorter than the test results. Including closure in the variable amplitude loadings greatly improves the predictions. 14 refs., 16 figs.

26087 (SAND–90-0782C) **Compatibility of Au base thick films with solder alloys: Solid state growth of intermetallics.** Stephens, J.J.; Romig, A.D. Jr. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004146–4: 16. DOE compatibility, aging and service life conference, Livermore, CA (USA), 24-26 Apr 1990). Order Number DE90009285. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Long term reliability of solder joints in thick film Au hybrid microcircuits require either minimization of the solid state growth of intermetallics or verification that if present, they do not compromise component performance. Intermetallic compounds such as $AuIn_2$ or $AuSn_4$ arise from the solid state reaction between Au thick films and 50Pb–50In or 63Sn–37Pb solder alloys, respectively; they are undesirable due to their brittle mechanical behavior caused by lack of a sufficient number of independent slip systems for plastic deformation. In addition, they may alter the resistivity of a circuit and thereby alter electronic performance. This paper will present a brief overview of the Au thick film inks/solder alloy systems whose intermetallic growth kinetics have been characterized at SNL, Albuquerque for hybrid microcircuit electronic applications. 6 refs., 3 figs., 2 tabs.

26088 (SAND–90-1080C) **An internal/external pressure, tension/compression multiaxial fatigue system.** Bourcier, R.J.; Jones, W.B.; Schmale, D.T. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900474–1: ASTM symposium on rapid load fracture testing, San Francisco, CA (USA), 23 Apr 1990). Order Number DE90009510. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

As computers become increasingly powerful, the constitutive models used in structural analysis codes become increasingly sophisticated. With the current generation of supercomputers, it now seems reasonable to consider incorporating relatively detailed representations of the multiaxial deformation response of engineering alloys. To aid in the development of such models and to allow measurement of their constituent parameters, we have designed a complex multiaxial deformation test system. The system to be described has been developed to perform non-proportional cycling of thin-walled metal tubes using internal/external fluid pressure and tensile/compressive axial loading. It has been added to an existing MTS 490 kN load frame with a PDP 11/34-based computer control system. Features of interest include; specimen grips, the high pressure chamber, the hydraulic intensifier and controller, and associated valving and switching. Initial software for this system has been written on the PDP 11/34 in the MTS MultiUser-BASIC language to perform simple proportional multiaxial cyclic deformation to a prescribed effective plastic strain limit.

26089 (UCRL–53947) **Formation of subsurface aluminum layers in beryllium by ion implantation and post-implant annealing.** Brown, D.W. Lawrence Livermore National Lab., CA (USA). Jan 1990. 196p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90007975. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

Subsurface layers of aluminum were formed in both monocrystalline and polycrystalline beryllium by implanting high doses of 200 keV Al^+ ions into beryllium and subsequently annealing the implanted material. Contrary to conventional wisdom on ion implantation, such layers demonstrate that ion implantation can in fact, be used, to form an essentially pure layer of an implanted species in a target material. In single crystal targets implanted at approximately 50°C, aluminum layer formation was critically dependent on the implanted dose. Cross-sectional transmission electron microscopy showed the aluminium layers were monocrystalline and had abrupt interfaces with the beryllium bulk and overlayer. Scanning electron microscopy revealed defects in the layers consisting of beryllium columns extending through the aluminum from the beryllium overlayer to the bulk. Study of implanted polycrystalline material showed that layer formation occurred for all grain orientations present, but that the defect density was grain dependent. An explanation of layer formation is developed based on the observed lamellar precipitate morphology in the as-implanted state and on predicted coarsening behavior of this morphology during annealing. 41 refs., 54 figs., 2 tabs.

26090 (WSRC-RP–89-970) **Aluminum-lithium target behavior.** McDonell, W.R. Westinghouse Savannah River Co., Aiken, SC (USA). Oct 1989. 43p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009132. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Information on physical properties and irradiation behavior of aluminum-lithium target alloys employed for the production of tritium in Savannah River reactors has been reviewed to support development of technology for the New Production Reactor (NPR). Phase compositions and microstructures, thermal conductivity, mechanical properties, and constituent diffusion phenomena of the alloys, established in prior site studies, are presented. Irradiation behavior, including distributions of product tritium and helium and related exposure limits due to swelling and cracking of the target alloys is discussed, along with gas release processes occurring during subsequent product recovery operations. The property review supports designation of the aluminum-lithium alloys as ideally well-suited target materials for low-temperature, tritium-producing reactors, demonstrated over 35 years of Savannah River reactor operation. Low temperature irradiation and reaction with lithium in the alloy promotes tritium retention during reactor exposure, and the aluminum provides a matrix from which the product is readily recovered on heating following irradiation. 33 refs., 26 figs., 8 tabs.

26091 Advanced Research and Technology Development Fossil Energy Materials Program. Judkins, R.R. (Oak Ridge National Lab., TN (USA). Metals and Ceramics Div.); Bradley, R.A. 8p. American Society of Mechanical Engineers, New York, NY (USA) (1988). (CONF-880607–: 33. ASME international gas turbine and aeroengine congress and exposition, Amsterdam (Netherlands), 5-8 Jun 1988).

88-GT-234.

The Advanced Research and Technology Development (AR and TD) Fossil Energy Materials Program is a multi-faceted materials research and development program sponsored by the Office of Fossil Energy of the U. S. Department of Energy. Technical activities on the program are divided into three research thrust areas: structural ceramic composites, alloy development and mechanical properties, and corrosion and erosion of alloys. In addition, assessments and technology transfer are included in a fourth thrust area. This paper provides information on the structure of the program and summarizes some of the major research activities.

26092 High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. MRS Symposium Proceedings. Volume 133. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. 794p. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The present conference on high-temperature ordered intermetallic alloys discusses alloy theory and phase stability, defects and microstructures, mechanical behavior, alloy design and material processing, multiphase and composite materials, nickel aluminides, titanium aluminides, and other ordered intermetallics. Attention is given to compositional effects on processing and properties of nickel aluminides, dynamic compaction and hot-isostatic-pressing of nickel aluminides, improvement of elevated-temperature material properties in Ni_3Al, the effect of microalloying B on the high-temperature mechanical properties of Ti_3Al, the effects of structure on creep of Ti-53.4 mol pct Al intermetallics, the deformation microstructure in Ni_3Si polycrystals strained over the range of temperature of flow stress anomaly, and the microstructure and mechanical properties of dual phase alloys consisting of the intermetallic phases.

26093 Effect of solutes on phase stability in Al_3Nb. Subramanian, P.R. (Oak Ridge National Lab., TN (USA)); Mendiratta, M.G.; Simmons, J.P.; Dimiduk, D.M. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The present investigation was directed toward exploring the potential for obtaining new ternary Al_2Nb-based intermetallics with the LI(2) structure. The effects of various ternary elements on the phase stability of Al_3Nb were studied by SEM, XRD, and EPMA. Results of the Al_3Nb-X phase relationship studies are presented. Preliminary microhardness results on the ternary DO(22) Al_3Nb-X

phases are also reported. The predictive capabilities of Pettifor's structural stability scheme are evaluated in the light of the present investigation. 12 refs.

26094 On microstructural evolution in gas atomized Ti-50 at. pct Al-2 at. pct Nb powder. Shih, D.S. (Oak Ridge National Laboratory, TN (USA)); Scarr, G.K.; Chesnutt, J.C. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Microstructural development in helium gas atomized Ti-50Al-2Nb powder has been characterized using X-ray diffractometry and transmission electron microscopy. The structure of the as-atomized powder was a mixture of two phases: an ordered fct L1/(0) gamma TiAl phase and an hcp alpha Ti phase containing fine (10-20 nm) D0(19) alpha(2) domains. Large powder (250 microns) contained 14 vol pct hcp phase, while fine powder (37 microns) contained 72 vol pct hcp phase. However, this alpha + alpha(2) constituent was metastable and transformed to the gamma phase during annealing. 14 refs.

26095 Angular dependent critical fields in NbTi-Ge superlattices in the weakly localized regime. Jin, B.Y. (Argonne Nat. Lab., Argonne, IL (US)); Ketterson, J.B.; Hilliard, J.E.; McNiff, E.J.; Foner, S.; Schuller, I.K. pp. 811 of Interfaces, superlattices, and thin films. Dow, J.D.; Schuller, I.K. Materials Research Society, Pittsburgh, PA (USA) (1987). (CONF-8612131–: Materials Research Society symposium on interfaces, superlattices and thin films, Boston, MA (USA), 1-6 Dec 1986).

The authors discuss the angular dependence of the upper critical fields, $H_c(\theta)$ for a set of NbTi-Ge superlattices studied at various temperatures. The behavior of $H_c(\theta)$ at lower temperatures deviates from the Tinkham expression which is expected to be valid only in the Ginberg-Landau regime close to T_c. They examine a model for calculating $H_c(\theta)$ involving the lowest eigenvalue of the gauge invariant diffusion equation (subject to boundary conditions appropriate to a slab) in the de Gennes expression for the upper critical field of a dirty superconductor at all temperatures. The disorder related localization and interaction effects , as well as the paramagnetic limiting effect, are also considered.

26096 In-situ observation of grain boundary behavior in Ni_3Al alloys during tensile deformation in SEM. Lin, D. (Oak Ridge National Laboratory, TN (USA)); Chen, D. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The deformation behavior of Ni_3Al alloys with various chemical compositions and subjected to different heat treatments were observed in situ in SEM. Moreover, in situ observations of slip trace are supplemented by the direct observation of dislocation arrangements by TEM. In boron-doped Ni_3Al alloys it is shown that, close to the grain boundary, there exists a thin slip transition region, within which slip lines are reoriented or other slip systems operate to produce a local strain accommodation and to relax the stress concentration at grain boundaries. However, boron-enhanced ductility is seriously affected by alloy stoichiometry, the addition of a tertiary alloy element, and heat treatment. 12 refs.

26097 High temperature creep behavior of single crystal gamma prime and gamma alloys. Nathal, M.V. (Oak Ridge National Laboratory, TN (USA)); Diaz, J.O.; Miner, R.V. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The creep behavior of single crystals of gamma-prime and gamma alloys were investigated and compared to the response of two-phase superalloys tested previously. High temperature deformation in the gamma alloys was characteristic of a climb-controlled mechanism, whereas the gamma-prime based materials exhibited glide-controlled creep behavior. The superalloys were much more creep resistant than their constituent phases, which indicates the importance of the gamma/gamma-prime interface as a barrier for dislocation motion during creep. 14 refs.

26098 Microchemistry and mechanics issues in stress corrosion cracking. Jones, R.H. (Lehigh Univ., Bethlehem, PA (USA)); Danielson, M.J.; Baer, D.R. pp. 707 of Fracture mechanics: Perspectives and directions. Wei, R.P.; Gangloff, R.P. American Society for Testing and Materials, Philadelphia, PA (US) (1989).

Environmentally-induced, subcritical crack growth occurs in most meatllic materials given the appropriate material, environment, and stress conditions. Although there have been considerble attempts to describe the rate-limiting steps in crack propagation, a number of issues are unresolved, including specifics about the crack-tip conditions, crack length effects, processes controlling the Stage I SCC region, and details about the crack advance processes in both transgranular stress corrosion cracking and intergranular stress corrosion cracking. A summary of these unresolved issues and some analysis of their effect on SCC are given in this paper. 46 refs.

26099 On the microscopic flow behavior of the phases present in Ti-24Al-11Nb. Gittis, S.J. (Oak Ridge National Laboratory, TN (USA)); Koss, D.A. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The deformation behavior of two alloys whose compositions (Ti-25Al-9Nb and Ti-11Al-23Nb in at. pct) correspond to alpha-two and beta phases in the Ti-24Al-11Nb alloy has been investigated. Results from both compression and tensile tests over a range of temperatures from 27 to 650 C indicate that the yield stress as well as the strain and strain-rate hardening characteristics of the Ti-24-11 alloy are controlled by the Ti3Al-base alpha-two phase. In contrast to the alpha-two alloy, the beta alloy has a flow stress which is very sensitive to temperature and strain rate at 650 C, suggesting the onset of high-temperature creep processes. 14 refs.

26100 Parameters for ductility improvement in TiAl. Kawabata, T. (Oak Ridge National Laboratory, TN (USA)); Izumi, O.; Tamura, Takashi. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The effect of the Ti/Al ratio and third elements (Cr, Hf, and Nb) on the mechanical properties of TiAl has been studied. Solution hardening in these elements is so large that the strength doubles by the addition of 3 at. pct Cr. Ductility to fracture strain has been improved by up to 2.7 percent and 2.7 percent by the Cr addition and the use of high-purity base metals, respectively. Parameters relating to the improvement of ductility are discussed: the improvement of ductility was caused by the decreases of the grain size, axial ratio, and impurity. 9 refs.

26101 Accurate determination of gamma-prime solvus in Ni-Al-X ternary systems. Hong, Y.M. (Oak Ridge National Laboratory, TN (USA)); Mishima, Y.; Suzuki, T. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

An attempt has been made to determine the gamma/gamma-prime phase boundaries with particular emphasis on the gamma-prime solvus in ternary Ni-Al-X systems, with X being one of the VA or VIA transition-metal elements. It is shown that the

gamma-prime solvus in each ternary system can be obtained as a surface with respect to composition and temperature by employing DTA and energy-dispersive X-ray spectroscopy combined with SEM. The DTA results often provide useful information on the phase relation in the vicinity of gamma and gamma-prime phase fields. 35 refs.

26102 Microstructures and mechanical behavior of two-phase niobium silicide-niobium alloys. Mendiratta, M.G. (Oak Ridge National Laboratory, TN (USA)); Dimiduk, D.M. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

In the Nb-Si system, it is possible to produce in situ composites consisting of a brittle Nb5Si3 intermetallic matrix and ductile Nb particles. The two phases are thermochemically stable up to about 1500 C and are amenable to wide microstructural variations including morphology, volume fraction, and the size of the individual microconstituents. This paper presents microstructures and phase transformations in these composites as a function of composition, and heat treatments and bend properties from room temperature to 1400 C.

26103 The location of tantalum atoms in Ni_3Al. Lin, H. (Oak Ridge National Laboratory, TN (USA)); Pope, D.P. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

An X-ray powder diffraction method was used to determine the location of tantalum atoms in Ni_3Al. A series of Ni3(Al,Ta) alloys was produced with tantalum content ranging from 0.1 to 3.0 at. pct. Fine powders with average particle sizes less than 80 microns were made from melt-spun ribbons by a grinding process. The values of the superlattice peak intensities normalized to the intensity of the (200) fundamental peak agreed with the calculated values assuming that tantalum atoms substitute on aluminum sites, not on nickel sites. Thus, it is concluded that tantalum atoms substitute for aluminum in Ni_3Al, except for Ta contents around 0.2 at. pct, where the data cannot be interpreted in terms of a simple substitution scheme. 5 refs.

26104 Structure of Copper-Hafnium multilayers. Clemens, B.M. (Brookhaven National Lab., Upton, NY (USA)); Stec, J.P.; Heald, S.M.; Tranquada, J.M. pp. 811 of Interfaces, superlattices, and thin films. Dow, J.D.; Schuller, I.K. Materials Research Society, Pittsburgh, PA (USA) (1987). (CONF-8612131–: Materials Research Society symposium on interfaces, superlattices and thin films, Boston, MA (USA), 1-6 Dec 1986).

The authors describe the structure of copper-hafnium multilayers studied as a function of composition modulation wavelength by x-ray diffraction and EXAFS. Sputter deposited samples were produced with composition modulation wavelengths of 1/2, 5, 7, 10, 14, and 20 close packed planes of each constituent per layer. The structure evolved anisotropically from amorphous to crystalline with increasing composition modulation wavelength, with crystalline order first appearing in the growth direction was not observed to extend beyond one elemental layer in any sample, and evidence for a disordered interfacial layer was observed by EXAFS for all samples.

26105 Notch effects on room temperature tensile and bend properties of Ni_3Al and Ni_3Al+B. Khadkikar, P.S. (Oak Ridge National Laboratory, TN (USA)); Rigney, J.D.; Lewandowski, J.J.; Vedula, K. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The notched mechanical properties of Ni_3Al and Ni_3Al+B prepared by powder metallurgy techniques have been determined in both tension and bending at room temperature. Tensile tests performed using double-notched specimens containing relatively blunt notches produced intergranular fracture in both Ni_3Al and Ni_3Al+B, with evidence of fracture initiating in an intergranular manner ahead of the blunt notch in both cases. Estimates of notched fracture toughness from bend tests and of local grain boundary fracture stress from the notched tensile tests suggest an increase in these values with boron addition. 8 refs.

26106 Study of cast Ni_3Al-base alloys. Zhou, Y. (Oak Ridge National Laboratory, TN (USA)); Zhang, T.; Tong, Y.; Zhang, B.; Zhu, Y. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

A series of cast Ni_3Al-base alloys with the addition of alloying elements, such as Hf, Zr, Ti, or Nb, have been studied, in which the total amount of Al and alloying elements substituting for Al was controlled in the range of 18 to 23 at. pct. It was found the alloying elements change remarkably the morphology, distribution and amount of gamma phase as well as the morphology and size of primary gamma-prime intermetallic compound. The size of primary gamma-prime can be decreased to micron order. The brittle gamma-prime - gamma-prime boundary can be substituted by tough gamma-prime - gamma - gamma-prime boundary. As a result, the mechanical properties of the cast Ni_3Al-base alloys, especially high-temperature ductility, can be enhanced. In addition, the effect of Cr is discussed when tested in air environment. It is considered that chromium addition is not very effective to improve the high-temperature embrittlement. 14 refs.

26107 Deformation behavior of NiAl-based alloys containing iron, cobalt, and hafnium. Pank, D.R. (Oak Ridge National Laboratory, TN (USA)); Koss, D.A.; Nathal, M.V. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The effects of alloying additions on the mechanical properties of the B2 intermetallic NiAl have been investigated in both the melt-spun ribbon and consolidated, bulk form. The study is based on a matrix of NiAl-based alloys with up to 20 at. pct Co and Fe additions and with reduced Al levels in the range of 30-40 at. pct. Characterization of the melt-spun ribbon by optical and scanning electron microscopy indicates a range of microstructures, including single-phase beta, gamma-prime necklace phase surrounding either martensitic or beta grains, and a mixture of equiaxed martensitic and gamma-prime grains. Bend ductility is present in melt-spun and annealed ribbons exhibiting the gamma-prime necklace structure and in a single-phase beta material containing 20 at. pct Fe. The analysis of compressive flow behavior on consolidated, bulk specimens indicates that the single-phase beta alloys exhibit a continuous decrease in yield stress with increasing temperature and profuse microcracking at grain boundaries. In contrast, multiphase (gamma-prime + either martensite or beta) alloys tend to display a peak in flow stress between 600 and 800 K, with little or no signs of microcracking. In general, heat treatments which convert the martensitic grains to beta + gamma-prime result in improved strength at temperatures above 600 K and better resistance to crack initiation. 8 refs.

26108 Deformation of a Ni-Al-Fe gamma/beta alloy. Field, R.D. (Oak Ridge National Laboratory, TN (USA)); Krueger, D.D.; Huang, S.C. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Room-temperature tensile tests were performed on annealed melt-spun ribbons of a 50Ni-20Al-30Fe alloy. The ribbons were found to possess a duplex structure consisting of fcc gamma and B2 beta grains and exhibited tensile elongations in excess of 10 percent while still maintaining good strength. The tested specimens were found to contain high dislocation densities in both the gamma and beta grains, with no indications of stress-induced martensite formation. Dislocation analysis revealed that the vast majority of dislocations in the beta have 100-line Burgers vectors; however, 111-line dislocations were also observed. Slip transfer was often facilitated by specific orientation relationships between the gamma and beta grains. 21 refs.

26109 Oxidation behavior of Ni_3Al-8Cr-0.1B alloy containing Zr addition. Guo, J. (Oak Ridge National Laboratory, TN (USA)); Sun, C.; Li, H.; Guan, H. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The isothermal oxidation behavior of Ni_3Al + 8Cr + 0.1B alloy containing zirconium addition was studied over a temperature range 850 to 1150 C and periods up to 100 h. The results show that isothermal oxidation kinetics of the alloys at various temperatures obey a parabolic law. The addition of zirconium to Ni_3Al-8Cr-0.1B alloy improves oxidation resistance at 850 to 950 C. However, the additive results in a considerable weight gain at 1050 to 1150 C. The structure of scale and phase transformation of the surface zone beneath the scale have been investigated. The addition of zirconium leads to the formation of adherent scale at all temperatures, since the internal oxides, like tree roots between the oxide scale and the substrate, are developed during oxidation. 7 refs.

26110 1200 to 1400 K slow strain rate compressive properties of NiAl/Ni_2AlTi-base materials. Whittenberger, J.D. (Oak Ridge National Laboratory, TN (USA)); Viswanadham, R.K.; Mannan, S.K.; Kumar, K.S. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

An attempt to apply the Martin Marietta Corporation's XD technology to the fabrication of NiAl-Ni_2AlTi materials with improved creep properties is presented. Composite materials, containing from 0 to 30 vol pct of nominally 1-micron-diameter TiB_2 particles in the intermetallic matrix have been produced by the XD process and compacted by hot pressing. Such composites demonstrated significant strength increases, approaching 3-fold for the 20 vol pct materials, in comparison to the unreinforced aluminide. This behavior was accomplished without deleterious side effects as the grain boundaries and particle-matrix interfaces were intact after compressive deformation to 10 percent or more strain. Typical true compressive stress-strain diagrams for materials tested in air between 1200 and 1400 K at approximate strain rates of 1.7 x 10 to the -6th/sec are presented. 9 refs.

26111 Processing and microstructure of melt spun NiAl alloys. Locci, I.E. (Oak Ridge National Laboratory, TN (USA)); Noebe, R.D.; Moser, J.A.; Lee, D.S.; Nathal, M. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The influence of various melt spinning parameters and the effect of consolidation on the microstructure of melt spun NiAl and NiAl + W alloys have been examined by optical and electron microscopy techniques. It was found that the addition of 0.5 at. pct W to NiAl results in a fine dispersion of W particles after melt spinning which effectively controls grain growth during annealing treatments or consolidation at temperatures between 1523 and 1723 K. Increased wheel speeds are effective at reducing both the ribbon thickness and grain size, such that proper choice of both composition and casting parameters can produce structures with grain sizes as small as 2 microns. Finally, fabrication of continuous fiber-reinforced composites which used pulverized ribbon as the matrix material was demonstrated. 11 refs.

26112 The effect of boron on the microstructure of Ni_2AlTi. Schuon, S.R. (Oak Ridge National Laboratory, TN (USA)); Rehzets, V. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Ingots with a nominal composition of Ni-34 at. pct Al-15 at. pct Ti + 0.0 wt pct B, 0.05 wt pct B, 0.1 wt pct B, or 0.3 wt pct B were prepared and compression-tested at a strain rate of 1.7 x 10 to the -7th/sec at room temperature, 650 C, 870 C, and 1000 C in air. Alloys were single-phase Ni_2AlTi, and borides were contained in all compositions containing boron. The compressive yield strength and the ultimate compressive strength of Ni_2AlTi containing boron is strongly affected by the type and distribution of borides. The formation of TiB2 at 0.3 wt pct B increased the strength at room temperature, 650 C, 870 C, and 1000 C, while the formation of a TiB-Ni_2AlTi eutectic at 0.05 wt pct and 0.1 wt pct B decreased strength at all temperatures. Crack deflection by TiB2 is an important strengthening mechanism at room temperature and 650 C. However, at 1000 C, dispersion strengthening may be an important strengthening factor. 11 refs.

26113 The effect of microalloying B on the high temperature mechanical properties of Ti3Al. Newkirk, J.W. (Oak Ridge National Laboratory, TN (USA)); Feldewerth, G.B. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The effect of adding boron to Ti_3Al on the microstructure and high-temperature tensile properties has been studied. Boron caused a large grain refinement that dominated the tensile properties at all temperatures. Particles of Ti2B were found in all of the boron-containing alloys. TiB was found only at concentrations of 0.1-percent B or more. 9 refs.

26114 A weak-beam study of the microstructure of beta-CuZn deformed in the domain of flow stress anomaly. Dirras, G. (Oak Ridge National Laboratory, TN (USA)); Beauchamp, P.; Veyssiere, P. High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Beta-brass single crystals oriented along 001 line were deformed between room temperature and 300 C. The deformation microstructure and dissociation properties were studied by transmission electron microscopy under weak-beam imaging conditions. Whatever the deformation temperature, superdislocations with 111-line Burgers vector and strong edge component dominate within the microstructure. In addition, below the temperature of the flow stress peak (about 250 C), the density of screw relative to mixed superdislocations decreases as straining temperature increases. Dissociation does not always occur on the slip plane, neither does it proceed exclusively by glide, even in samples deformed at 100 C. 17 refs.

26115 A structural investigation of $Ag_{0.167}TiS_2$ by time-of-flight neutron powder diffraction. Burr, G.L. (Arizona State Univ., Tempe (USA)); Young, V.G. Jr.; McKelvy, M.J.; Glaunsinger, W.S.; Von Dreele, R.B. *Journal of Solid State Chemistry (USA)*, 84(2): 355-364 (Feb 1990). DOE Contract W-31109-ENG-38.

The structure of $Ag_{0.167}TiS_2$ has been determined at several temperatures from time-of-flight neutron powder diffraction data. At 305 K, $Ag_{0.167}TiS_2$ is a stage-II complex which belongs to the space

group $P\bar{3}m1$, with a = 3.4161(4) Å and c = 12.100(2) Å. When the temperature is lowered to 13 K, the lattice parameters decrease, but no phase change or superlattice formation is observed. Upon heating to 1123 K, this compound transforms to a stage-I structure belonging to the space group $P\bar{3}m1$, with a = 3.4676(1) Å and c = 6.2247(4) Å. No further phase changes are observed when the temperature is raised to 1323 K. When this compound is slowly cooled to ambient temperature from 1323 K, it transforms quantitatively to the original stage-II structure. The Rietveld refinements of $Ag_{0.167}TiS_2$ at six temperatures are presented and discussed.

26116 Photoemission from mass-selected monodispersed Pt clusters. Eberhardt, W. (Exxon Research and Engineering Company, Route 22E, Annandale, New Jersey 08801 (USA)); Fayet, P.; Cox, D.M.; Fu, Z.; Kaldor, A.; Sherwood, R.; Sondericker, D. *Physical Review Letters (USA)*, 64(7): 780-783 (12 Feb 1990).

We report measurements of the valence- and core-level photoemission spectra of mass-selected, monodispersed Pt clusters. For individual samples consisting of the platinum atom through the six-atom cluster deposited onto a silica substrate, we have followed the development of the individual valence-band electronic structure and the Pt 4*f* core-electron binding energy, and conclude that such small metal clusters do not yet exhibit metallic character.

26117 Fully automated system for simultaneous measurement of thermal conductivity and heat capacity from 4 to 300 K. Kwok, R.S. (Department of Physics and Solid State Science Center, University of California, Los Angeles, California 90024 (USA)); Brown, S.E. *Review of Scientific Instruments (USA)*, 61(2): 809-813 (Feb 1990).

A fully automated system which is capable of measuring specific heat and thermal conductivity simultaneously from liquid helium to room temperature is presented. Thermal conductivity is measured by a steady-state longitudinal heat flow technique, and specific heat by a thermal relaxation method. A numerical simulation of the one-dimensional heat flow equation is used to examine the basic operational principle. The method is tested using GE 214 fused quartz and AISI 304 stainless-steel rods, and the results compare favorably with values quoted in the literature.

26118 Inhibition of C-H and C-O bond activation by surface oxygen: Stabilization of surface phenoxide in the reaction of phenol on oxygen-precovered Mo(110). Serafin, J.G. (Harvard Univ., Cambridge, MA (USA)); Fried, C.M. *Journal of the American Chemical Society (USA)*, 111(12): 4233-4239 (7 Jun 1989). DOE Contract FG02-84ER13289.

The presence of surface oxygen on Mo(110) is shown to increase the kinetic stability of surface phenoxide formed after saturation phenol exposure with respect to decomposition. Temperature-programmed reaction and x-ray photoelectron spectroscopies have been used to study the reactions of phenol (C_6H_5OH) on oxygen-precovered Mo(110) (θ_0 = 0.33). At saturation coverage, surface phenoxide is formed from cleavage of the phenol O-H bond at temperatures below 400 K and is stable on the surface to 650 K, where it undergoes disproportionation to gaseous phenol (E_d = 42 kcal/mol) and the decomposition products gaseous water, gaseous dihydrogen, and surface carbon. A trace amount of benzene is also produced from decomposition of surface phenoxide. The hydrogen released by O-H bond cleavage in phenol at low temperature reacts with oxygen in the oxide overlayer to form gaseous water at temperatures below 400 K. Intact molecular phenol is also desorbed at temperatures below 350 K. The atomic oxygen overlayer dramatically stabilizes C-O and C-H bonds in the surface phenoxide species, which are cleaved at ≈ 370 K on the clean Mo(110) surface. The stability of surface phenoxide on the oxygen-precovered surface is dependent on the coverage of phenol-derived surface species, with decomposition occurring at lower temperature for lower phenol exposures. No gaseous phenol is reformed from phenoxide for low phenol exposures.

26119 Preresonance Raman studies of metal-to-ligand charge transfer in $(NH_3)_4Ru(2,2'\text{-bpy})^{2+}$. In situ bond length changes, force constants, and reorganization energies. Doorn, S.K. (Northwestern Univ., Evanston, IL (USA)); Hupp, J.T. *Journal of the American Chemical Society (USA)*, 111(13): 4704-4712 (21 Jun 1989). DOE Contract FG02-87ER13808.

As a prototype for charge-transfer reactions in general, the intense metal-to-ligand charge-transfer transition occurring in $Ru(NH_3)_4(bpy)^{2+}$ (bpy = 2,2′-bipyridine) has been examined experimentally by resonance and preresonance Raman spectroscopy and analytically by time-dependent scattering theory. To their knowledge, the present example represents the first application of the theory to charge-transfer problems. From the experiments and corresponding theory, the normal-coordinate changes accompanying the transition have been calculated. Both metal-ligand and intraligand bonds are found to distort significantly. When the distortion data are combined with the observed vibrational frequencies, a mode-by-mode assessment of the inner-shell reorganization energy is possible. Further experiments, in which the nature of the solvent is systematically varied, show that selected force constants (and therefore selected components of the internal reorganization energy) are modulated significantly (ca. 6-11 %) by ligand-solvent hydrogen bonding. Finally, variations in the nature of the solvent are found to shift ground- and/or excited-state energies in such a way as to either enhance or attenuate the occurrence of net photochemistry.

26120 Structural characterization of photoexcited ruthenium(II) octaethylporphyrin. Crawford, B.A. (Univ. of New Mexico, Albuquerque (USA)); Ondrias, M.R. *Journal of Physical Chemistry (USA)*, 93(13): 5055-5061 (29 Jun 1989).

The nature of photoexcited and photoproduct species of Ru^{II} octaethylporphyrins has been investigated using absorption, infrared, and transient resonance Raman spectroscopies. The photodynamic behavior of $Ru^{II}(CO)OEP$ in coordinating and noncoordinating solvents is governed by both CO back-bonding and the σ-donating character of the axial ligands. $Ru^{II}(CO)OEP$ in coordinating solvent undergoes CO photolysis followed by the rapid irreversible addition of a ligand to form the bis-ligated product. In contrast, photoexcitation of $Ru^{II}(CO)OEP$ in methylene chloride or bromobenzene does not result in CO ejection but yields a metastable species whose vibrational properties are consistent with a charge-transfer species. The photodynamics of $Ru^{II}OEP(pip)_2$, on the other hand, produces a transient species within the laser pulse that is interpreted to arise from a $d \rightarrow \pi^*$ transition.

26121 Single-crystal X-ray and neutron diffraction studies of an η^2-dihydrogen transition-metal complex: trans-$[Fe(\eta^2\text{-}H_2)(H)(PPh_2CH_2CH_2PPh_2)_2]BPh_4$. Ricci, J.S. (Univ. of Southern Maine, Portland (USA)); Koetzle, T.F.; Bautista, M.T.; Hofstede, T.M.; Morris, R.H.; Sawyer, J.F. *Journal of the American Chemical Society (USA)*, 111(24): 8823-8827 (22 Nov 1989). DOE Contract AC02-76CH00016.

The H-H distance in the η^2H_2 ligand in $[Fe(\eta^2\text{-}H_2)H(dppe)_2]BPh_4$, 1 BPh_4, dppe = $PPh_2CH_2CH_2PPh_2$, is 0.816 (16) Å as determined by neutron diffraction on a crystal of volume 2.62 mm^3 at 20 K: 1-BPh_4 is monoclinic, space group C2/c, a = 16.999 (7) Å, b = 16.171 (2) Å, c = 22.114 (5) Å, β = 102.52 (2)°, U = 5,934.4 (2) $Å^3$, and D_c = 1.315 g cm^{-3} for Z = 4; R(F) = 0.071, $R(F^2)$ = 0.110, $R_w(F^2)$ = 0.113 for 4,116 reflections with I { >=} 3σ(I). The H-H separation is 0.87 (3) Å as determined by X-ray diffraction at 298 K: monoclinic, C2/c, a = 17.327 (3) Å, b = 16.407 (4) Å, c = 22.224 (3) Å, β = 102.87 (1)°, U = 6,159.2 (1) $Å^3$, and D_c = 1.267 g cm^{-3} for Z = 4; R(F) = 0.038, $R_w(F)$ = 0.034, for 3,673 reflections (I { >=} 3σ(I)). These η^2-H_2 distances agree with the X-ray value of 0.89 (11) Å reported for the tetrafluoroborate salt, 1-BF_4. As was found for 1-BF_4, 1-BPh_4 contains an η^2-H_2 ligand that is symmetrically side-on bonded to the iron and trans to the terminal hydride such that the Fe has a distorted octahedral configuration. These diffraction studies serve to calibrate H-H distances obtained by the T_1 NMR method for dihydrogen complexes in solution where the H_2 ligand is suggested to be rapidly spinning. The H-H distance is the same as that in $W(\eta^2\text{-}H_2)(CO)_3(P(i\text{-}Pr)_3)_2$ despite the fact that the tungsten complex has a more labile H_2 ligand. The terminal hydride-iron distance of 1.535 (12) Å as determined by neutron diffraction is shorter than the distances to the dihydrogen ligand (H-Fe = 1.616 (10) Å).

26122 A laser flash photolysis study of photodehydroxylation phenomena of 9-phenylxanthen-9-ol and photobehavior of

related intermediates. Enhanced electrophilicity of 9-phenylxanthenium cation singlet. Minto, R.E. (Univ. of Notre Dame, IN (USA)); Das, P.K. *Journal of the American Chemical Society (USA)*, 111(24): 8858-8866 (22 Nov 1989).

In the course of 248-nm laser flash photolysis, solutions of 9-phenylxanthen-9-ol (1) undergo homolytic and heterolytic photodehydroxylation, the relative efficiency of which depends strongly on the solvent nature. Polar/hydroxylic solvents, particularly aqueous mixtures, cause copious formation of 9-phenylxanthenium cation (2), the ground, and excited-state properties of which are conveniently studied by single- and double-laser flash photolysis. In 1:1 H_2O/MeCN, the quantum yield of carbenium ion generation is 0.4 ± 0.1; only 1 % of photoheterolysis occurs through an adiabatic route. Surprisingly, in polar but nonhydroxylic solvents (e.g., acetonitrile and 1,2-dichloroethane) also, the cation is photogenerated in small but sufficient yields to allow time-resolved spectroscopic detection and study in these relatively neutral and inert media. In relatively nonpolar solvents, e.g., n-heptane and benzene, the photolysis of 1 is dominated by homolytic cleavage to 9-phenxylxanthenyl radical (3). The short-lived triplets of 1 (τ_T { <=} 0.3 μs) are also observed in nonaqueous solvents (ϕ_T = 0.05 in acetontrile). In comparison to the weak, fast-decaying, doublet-doublet fluorescence of 3 (λ_{max}^F = 590 nm, τ_F { <=} 5 ns), the singlet-singlet fluorescence from 2 is intense and long-lived (λ_{max}^F = 550 nm, τ_F = 25 ns in acetonitrile in the absence of nucleophilic quenchers) and is almost nonquenchable by oxygen (k_q { <=} 5 x 10^8 M^{-1} s^{-1}). The electrophilicity of the lowest excited singlet state of 2, measured in terms of rate constants (k_q) of bimolecular quenching by anions and lone-pair containing molecules, is considerably more pronounced than that of the ground state (that is, k_q are higher for the excited state by several orders of magnitude).

26123 Synthesis of rhenium-alkene complexes from the reaction of the heterobimetallic dihydride $C_5H_5(CO)_2HRe$-PtH$(PPh_3)_2$ with alkynes. Casey, C.P. (Univ. of Wisconsin, Madison (USA)); Rutter, E.W. Jr. *Journal of the American Chemical Society (USA)*, 111(24): 8917-8919 (22 Nov 1989).

Heterobimetallic compounds hold great promise as catalysts since the 2 different metals have the potential of acting cooperatively. The authors report that the new heterobimetallic dihydride $C_5H_5(CO)_2HRe$-PtH$(PPh_3)_2$ (I)[2] acts as a catalyst for ethylene hydrogenation and reacts stoichiometrically with alkynes to produce rhenium-alkene complexes.

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Refer also to citation(s) 25587, 25972, 26048, 26068, 26075, 26083, 26091, 26098, 26110, 26216, 26222, 26287, 26313, 26330, 26342, 27177, 27332

26124 (AD-A-216144/6/XAB) **Processing and mechanical properties of high-temperature/high-performance composites. Book 4, Section 3: Flow and creep strength. Annual report, 15 September 1988-14 September 1989.** California Univ., Santa Barbara, CA (USA). Dept. of Materials. 15 Oct 1989. 194p. Available from NTIS, PC A09/MF A02.

Substantial activity has been initiated to examine creep strength and ductility during both plastic flow and creep in the presence of reinforcements. The variables of principal interest are the reinforcement aspect ratio and size, as well as their fracture/debond resistance. Papers include: Flow strength and ductility of an aluminum alloy reinforced with SiC particulates; Aspects of the high temperature performance of ceramics and ceramic composites; Brittle-to-ductile transition in silicon carbide; Mechanical properties of particulate-reinforced aluminum-matrix composites; Combined Mode I - Mode III fracture toughness of alumina particulate-reinforced aluminum alloy-matrix composites; Numerical study of high temperature creep deformation in metal-matrix composites; Plastic flow in ductile materials containing a cubic array of rigid spheres; Influence of pressure on damage evolution and fracture in metal-matrix composites; Fracture mechanism maps in stress space.

26125 (AD-A-216195/8/XAB) **Investigation of the failure modes in a metal-matrix composite under thermal cycling. Master's thesis.** Ermer, P.G. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Dec 1989. 135p. (AFIT/GAE/ENY-89D-07). Available from NTIS, PC A07/MF A01.

There is currently wide interest in producing a vehicle capable of hypersonic flight. Structural materials in such a vehicle must be able to withstand high temperatures and retain high stiffness. Metal matrix composites (MMCs) are rapidly becoming the strongest candidates for these applications and concurrently, the need to study the effects of thermal cycling on them. This study emphasizes the development of a computer-controlled testing system that thermally fatigues a specimen under a variety of thermal conditions. A titanium matrix composite with silicon carbide fibers (SCS6/Ti-15-3) is the object of this study. To demonstrate the capability of this system, ten thermal fatigue tests were completed. The MMC was cycled from 300 F to 800 F while collecting strain and temperature data. A systematic study was undertaken to investigate the initiation and progression of the damage and its effect on mechanical properties as a function of applied thermal stresses. Results show that for up to 16,750 cycles, material properties remain unchanged and do not correlate with thermal cycling. Interior damage begins at 500 cycles as deformation of the fiber/matrix interface. Exterior damage begins at 1,500 cycles as delamination cracks along the ply seams.

26126 (ANL/PPRNT-90-209) **Core level x-ray photoemission of the high T_c $CaSr_2Bi_2Cu_2O_x$ superconductor.** Veal, B.W.; Paulikas, A.P.; Downey, J.W. Argonne National Lab., IL (USA). Apr 1988. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90009166. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The x-ray photoemission spectroscopy (XPS) signatures of Cu core levels in $CaSr_2Bi_2Cu_2O_x$ are distinctly different from those of Bi and of Ca in this high $T_c$superconductor. The Cu signatures are very similar to those of Cu in $YBa_2Cu_3O_{6.9}$. The Cu 2p spectra, in both cases, indicate that the photoexcited ion has poor (ionic) coupling to screening electrons. In contrast, the spectra of Bi and Ca in $CaSr_2Bi_2Cu_2O_x$ are indicative of good (metallic) coupling between the ion and screening electrons. These observations illuminate the connection between high $T_c$superconductivity and the coupling of Cu ions with conduction electrons. 15 refs., 4 figs.

26127 (CEA-CONF-9902) **High-energy xenon ion irradiation effects on the electrical properties of yttrium iron garnet.** Costantini, J.M. (CEA Centre d'Etudes de Bruyeres-le-Chatel, 91 (FR)); Flament, J.L.; Sinopoli, L.; Trochon, J.; Uzureau, J.L.; Groult, D.; Studer, F.; Toulemonde, M. CEA Centre d'Etudes de Bruyeres-le-Chatel, 91 (France). 1989. 3p. (CONF-8905283-: SHIM 89: 1. international symposium on swift heavy ions in matter, Caen (France), 16-19 May 1989). Order Number DE90762051. Available from NTIS (US Sales Only), PC A02/MF A01.

Thin monocristalline samples of yttrium iron garnet $Y_3Fe_5O_{12}$ (YIG) were irradiated at room temperature with 27 MeV/A ^{132} Xe ions at varying fluences up to 3.5 x 10^{12} ions cm^{-2}. Sample thickness (100 μm) was smaller than the mean projected range of ions (170 μm) so that we were able to study the effects of irradiation damage solely. At such a high ion energy the nuclear energy loss is negligible and damage is mainly due to electronic excitation energy loss. YIG d.c conductivity is found to rise by a factor 40 for the highest dose while the permittivity increases only slightly after irradiation (40% max.). The dielectric losses are also enhanced as the ion fluence increases especially at lower frequencies (by a factor 6 at 10 KHz). No dielectric relaxation peak is observed in the frequency range explored here (10 KHz - 10 MHz).

26128 (CONF-900466-3) **Morphology control in precursor ceramic powder production by the Electrical Dispersion Reactor.** Harris, M.T.; Scott, T.C.; Basaran, O.A.; Byers, C.H. Oak Ridge National Lab., TN (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90009472. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Electrical Dispersion Reactor (EDR) allows the continuous production of composite oxide ceramic precursor materials. Silica particles in the form of highly porous shells are produced by the hydrolysis of tetraethylorthosilicate as the continuous phase and

water-ammonia as the disperse phase, reflecting the diffusion of the silicon moiety into the dispersed phase. Alternately, denser silica particles result when aqueous solutions of sodium metasilicate are dispersed in a continuous phase containing acetic acid in 2-ethyl-1-hexanol. Additionally, spherical particles in the size range 0.1 to 2 microns are produced from the dispersion of aqueous solutions containing cupric chloride or a mixture of cupric chloride, yttrium nitrate, and barium nitrate (3:1:2 molar ratio) into a continuous organic phase containing ammonia. 5 refs., 4 figs.

26129 (CONF-8904275–, pp. 4, Paper 55) **Ion beam modification on the Y-Ba-Cu-O system with the MEVVA high current metal ion source.** Brown, I.G. (Lawrence Berkeley Lab., CA (USA)); Rubin, M.D.; Yu, K.M.; Mutikainen, R.; Cheung, N.W. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The authors have used high-dose metal ion implantation to fine tune the composition of Y-Ba-Cu-O thin films. The films were prepared by either of two rf sputtering systems. One system uses three modified Varian S-guns capable of sputtering various metal powder targets; the other uses reactive rf magnetron sputtering from a single mixed-oxide stoichiometric solid target. Film thickness was typically in the range 2000-5000 A. Substrates of magnesium oxide, zirconia-buffered silicon, and strontium titanate have been used. Ion implanation was carried out using a metal vapor vacuum arc (MEVVA) high current metal ion source. Beam energy was 100-200 keV, average beam current about 1 mA, and dose up to about 10^{17} ions/cm^2. Samples were annealed at 800-900°C in wet oxygen. Film composition was determined using Rutherford Backscattering Spectrometry (RBS), and the resistivity versus temperature curves were obtained using a four-point probe method. They find that the zero-resistance temperature can be greatly increased after implantation and reannealing, and that the ion beam modification technique described here provides a powerful means for optimizing the thin film superconducting properties. 23 refs., 4 figs.

26130 (CONF-9004154–1) **Review of the state of the technology for joining ceramics for high-temperature structural applications.** Moorhead, A.J.; Kim, Hyoun-Ee. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 5. international symposium on advanced technology in welding, materials processing and evaluation; Tokyo (Japan); 17-19 Apr 1990. Order Number DE90009224. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Three major processes are reviewed for joining ceramics for structural applications; i.e., those which impose significant stresses, at elevated temperatures, and in corrosive environments. Included are discussions on diffusion welding, brazing with filler metals, and brazing with nonmetallic filler materials (glasses). 67 refs., 7 figs.

26131 (CONF-9004159–2) **Modeling high-temperature superconductors and metallic alloys on the Intel iPSC/860.** Geist, G.A.; Peyton, B.W.; Shelton, W.A.; Stocks, G.M. Oak Ridge National Lab., TN (USA). [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 5. distributed memory computing conference; Charleston, SC (USA); 9-12 Apr 1990. Order Number DE90009402. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Oak Ridge National Laboratory has embarked on several computational Grand Challenges, which require the close cooperation of physicists, mathematicians, and computer scientists. One of these projects is the determination of the material properties of alloys from first principles and, in particular, the electronic structure of high-temperature superconductors. While the present focus of the project is on superconductivity, the approach is general enough to permit study of other properties of metallic alloys such as strength and magnetic properties. This paper describes the progress to date on this project. We include a description of a self-consistent KKR-CPA method, parallelization of the model, and the incorporation of a dynamic load balancing scheme into the algorithm. We also describe the development and performance of a consolidated KKR-CPA code capable of running on CRAYs, workstations, and several parallel computers without source code modification. Performance of this code on the Intel iPSC/860 is also compared to a CRAY 2, CRAY YMP, and several workstations. Finally, some density of state calculations of two perovskite superconductors are given. 10 refs., 4 figs.

26132 (ENEA-RT-TIB–89-22) **Sintering and hot pressing of SiC and Si_3N_4 based ceramic materials: Preliminary tests.** Nannetti, C.A. ENEA, Casaccia (Italy). Dipt. Tecnologie Intersettoriali di Base. Jun 1989. 19p. (In Italian). (RT/TIB–89-22). Order Number DE90764308. Available from NTIS (US Sales Only), PC A03/MF A01.

Pressureless sintering and hot-pressing of commercially available beta-SiC and alpha-Si_3N_4 powders were preliminary investigated. Beta-SiC doped with small amounts of boron and carbon was hot-pressed at 2050 C for a period of 20 min. in flowing He at atmospheric pressure, to a final density greater than 99% of theoretical. With the same thermal treatment, sintered specimens achieved about 93% of theoretical density. Despite the presence of a large population of isolated voids of 100 microns or greater in size, the room temperature flexure strength of pressed and sintered bars (250 MPa) was rather promising. Alpha Si_3N_4 based materials were hot pressed at 1700 C in flowing nitrogen at atmospheric pressure, to final densities higher than 96% of theoretical.

26133 (Juel-Conf–77, pp. 125-133) **Densification of highly reactive aluminium titanate powders.** Gasic, M. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)); Stamenkovic, I.; Ondracek, G. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

This paper describes the investigation of densification process of aluminium titanate powders obtained via hydrolysis of Ti-alkoxide in presence of corundum or by hydrolysis of two alkoxide components (cohydrolysis). The experimental work was realized with isostatic pressing followed by sintering as well as with hot pressing technique. (orig./MM).

26134 (Juel-Conf–77, pp. 111-118) **The optimization of powders for use in sintering.** Brook, R.J. (Max-Planck-Institut fuer Metallforschung, Stuttgart (Germany, F.R.). Pulvermetallurgisches Lab.). Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

In recent years the introduction of chemical preparation methods has greatly improved the quality of control which can be exercised over the properties of powders intended for use in sintering. It is therefore now important to identify the desired powder characteristics so that powders of optimal quality can be prepared. A number of the properties of powders which need to be considered in such a design process are reviewed. (orig.).

26135 (Juel-Conf–77, pp. 135-147) **High-tech aluminium titanate ceramics.** Stamenkovic, I. (Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl Glas und Keramik und Inst. fuer Gesteinshuettenkunde); Bossert, J.; Ondracek, G.; Stumpfe, W. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

To prepare pure ('high tech') aluminium titanate powders two preparation routes have been performed: the solid state reaction of oxidic components, the sol-gel route. The surface areas of aluminium titanate powders prepared by solid state reaction of alumina and titania at 1500deg C and subsequent different milling procedures ranged between 3.2 and 5.5 m^2/g. According to sintering experiments performed at 1500deg C the sinterability of these powders was restricted. Sintered samples contained grains of about 4 micrometers in diameter and microcracking was revealed. Due to the milling procedure impurities were present in all sintered materials. Sol-gel routes led to fine aluminium titanate powders the surface areas of which ranged between 25 m^2/g in the case of hydrolysis route and 255 m^2/g if the cohydrolysis route was used. This serie of aluminium titanate (AT) powders was characterized by very poor cold compactibility (< 58% TD) but provides extremely high sinterabilities; high dense samples (≥ 95% TD) have been obtained at sintering temperatures of about 1400deg C. The material was pure and fine grained and in those cases, where the grain size ranged below one micrometer, no microcracking was noticed in the bulk ceramics. (orig.).

26136 (Juel-Conf–77, pp. 161-176) **Influence of water removal rate during calcination on the crystallization of ZrO_2 from amorphous hydrous precipitates.** Kosmac, T. (Institut Jozef Stefan, Ljubljana (Yugoslavia)); Krasevec, V.; Gopalakrishnan, R. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

In this work the crystallization of metastable tetragonal zirconia from amorphous hydrous precipitate was studied with respect to various calcination conditions, such as vacuum (1 mbar) and flowing dry or wet hydrogen or oxygen. DTA and TGA measurement were performed in air and in reduced (1 mbar) air pressure. Phase identification was based on X-ray diffraction profiles. (MM).

26137 (Juel-Conf–77, pp. 177-185) **Tape casting and sintering of AlN.** Claassen, T. (Technische Univ. Hamburg-Harburg, Hamburg (Germany, F.R.). Arbeitsbereich Technische Keramik); Nischik, C.; Greil, P. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

The aim of this work is to examine the influence of the powder processing conditions and the slurry composition on the oxygen content of tape cast AlN. The chemical composition of the non-aqueous AlN slurry must be optimized with respect to slurry rheology and residual oxygen content in the sintered products. (orig./MM).

26138 (Juel-Conf–77, pp. 187-195) **Influence of processing on the properties of β-SiC powders.** Kevorkijan, V. (Institut Jozef Stefan, Ljubljana (Yugoslavia)); Komac, M.; Kolar, D.; Smalc, A.; Rottmann, J. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

The pressureless sintering of SiC to high final densities requires extremely fine and chemically pure starting powders. Prior to batch preparation and shaping, adequate processing of powders is therefore necessary, which commonly involves comminution, classification and chemical purification. β-SiC powders which were used in the present investigation were either prepared by the authors via carbothermic reduction of SiO_2 or supplied by H.C. Starck (B-10), Ibiden (UF-0090), Mitsui Toatsu (MSC 20) and Superior Graphite (HSC 100 GL). (orig./MM).

26139 (Juel-Conf–77, pp. 197-203) **Corrosion of SiSiC by gases and basic slag at high temperature.** Foerthmann, R. (Kernforschungsanlage Juelich GmbH (Germany, F.R)); Gruebmeier, E.; Naoumidis, A.; Kevorkijan, V.M. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

The corrosion behaviour of silicon-infiltrated silicon carbide (SiSiC) and the corrosion-induced changes of mechanical properties were investigated at temperatures between 1200 and 1400deg C without and with contact to a basic coal slag. Isothermal gas corrosion tests were made by using tube furnaces. The furnace was supplied with different gases (air, nitrogen, hydrogen) or mixtures of these gases which can be saturated additionally by water vapour. The slag corrosion tests were done by covering the samples with slag powder and heating in air at 1250deg C. (orig./MM).

26140 (Juel-Conf–77, pp. 297-311) **Comparative studies on post-HIP- and sinter-HIP treatments on transformation toughened ceramics.** Oberacker, R. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Inst. fuer Keramik im Maschinenbau); Kuehne, A.; Thuemmler, F. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

There are different variants of hot isostatic pressing methods (HIP): 1. Encapsulated HIP, 2. Post-HIP and 3. Sinter-HIP. Encapsulated HIP is very expensive due to the requirements for the capsule material at the high processing temperature which are necessary. The containerless methods (2. + 3.) differ in principle only from each other by the intermediate cooling and reheating step during the Post-HIP treatment, which is avoided in the Sinter-HIP process. Comparative evaluations of the last two HIP methods are made with high strength tetragonal zirconia with 2 (TZP-2Y), resp. 3 mole% (TZP-3Y) of Y_2O_3 as stabilizer and ZrO_2 toughened Al_2O_3 containing 10 to 21 vol% of unstabilized ZrO_2 (ZTA-10 ... ZTA-21) as model ceramic materials. (MM).

26141 (Juel-Conf–77, pp. 283-296) **Synthesis of high density cordierite bodies.** Seide, O. (Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl Glas und Keramik und Inst. fuer Gesteinshuettenkunde); Kroenert, W. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

The experimental work was realized with two different prereacted cordierite samples: A - synthesized by solid state reaction of raw materials, B - obtained by devitrification of glass having cordierite composition. The starting powders were prepared by intensive attritor milling achieving similar physical properties. The green body densities ranged between 60% and 70% of theoretical density pressed between 100 and 350 MPa. Sintering experiments realized in the temperature range from 1200 to 1350deg C revealed the following: (a) The influence of pressure on sintered bodies were evident up to 1300deg C for powder A and 1250deg C for B. (b) Higher sintering densities of sample A were ascribed to its higher impurity content. (c) Sample A sintered at 1350deg C reached α95% of theoretical density showing uniform microstructure. Sample B treated under the same conditions sintered to density of α90% of theoretical density and developed similar microstructure. (orig.).

26142 (Juel-Conf–77, pp. 313-325) **Process development for sinter-HIPing of SiC.** Fetahagic, T. (Institut Jozef Stefan, Ljubljana (Yugoslavia)); Oberacker, R.; Thuemmler, F. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

Pressureless sintering of SiC to high density levels requires the presence of additives which often remain at the grain boundaries and deteriorate the mechanical high temperature properties. Encapsulated HIPing allows to avoid this problem but is very expensive due to the requirements for the capsule material at the high processing temperature which are necessary. Post-HIP treatments result only in a marginal increase of mechanical properties. Therefore Sinter-HIP processing of SiC is investigated. In the first part of the work a systematic investigation on sintering behavior of SiC is carried out with the goal, to reach the pore closure of the material with a minimal amount of additives (Al and/or B) at HIP-compatible temperatures. The microstructure present at this state of densification is characterised and will be correlated with the densification behaviour under high pressure investigated in the proceeding part of this work. (orig./MM).

26143 (Juel-Conf–77, pp. 329-347) **Precipitation mixing of silicon nitride with bimetallic oxides.** Oroschin, W. (Technische Univ. Hamburg-Harburg, Hamburg (Germany, F.R.). Arbeitsbereich Technische Keramik); Kulig, M.; Greil, P. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

Sol-gel coating of submicron silicon nitride powder by hydroxide precipitation from bimetallic alkoxides (as sintering aids) in non-aqueous solution was examined. Mg-Al, Y-Al, and Nd-Al alkoxide mixtures were prepared with various intermetallic ratio. The precipitation of the bimetallic hydroxides in the silicon nitride powder resulted in an improved elemental distribution as compared to the mechanically mixed powder. Acoustophoretic measurements in aqueous solution indicate a surface coating of the silicon nitride with a hydroxide gel-layer which significantly changes the surface chemistry and the structure of the electric double layer. Depending on the dissolution and electrlolyte adsorption behaviour of the metal hydroxides a surface activation may be observed in the precipitation mixed powder which may be used for optimizing the slip casting and pressing properties of sinterable silicon nitride powder mixtures. (orig./MM).

26144 (Juel-Conf–77, pp. 407-412) **Microstructural studies on alumina-zirconia and metallized alumina ceramics.** Bratovic, S. (Energoinvest, Sarajevo (Yugoslavia)); Derviskadic, J.; Djuricic, B.; Jamakosmanovic, M.; Mulalic, M.; Trubelja, M. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

Two separate topics are discussed in this paper. The microstructural aspects of high-temperature metallizing of Al_2O_3 ceramics are described first. In this context, several observations on the ceramic-to-metal interfaces are presented. They lead to a broad conclusion about the bonding mechanism between alumina and the metallizing layer. In the second part, initial results on microstructural and phase analyses of Al_2O_3-ZrO_2 composites are presented. These results indicate that an 'optimum' microstructure was achieved in the Al_2O_3-15 vol.% ZrO_2 composite. However, it was concluded that the processing route (particularly milling) needs modification in order to obtain the expected improvements in mechanical properties and/or thermal-shock resistance of the composites. (orig.).

26145 (Juel-Conf–77, pp. 499-506) **Phase relations in the Y-Si-Al-O-N system: Controlled manufacturing of α/β-SiAlON composites.** Boskovic, S. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)); Nickel, K.G.; Petzow, G. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

A systematic study of phase relations in the Si_3N_4-rich corner of the Si_3N_4-$SiAl_2O_2N_2$-YAl_3N_4 plane of the Y-Si-Al-O-N system showed the existance of a compositional window in which composites of α- + β-SiAlON coexisting with minor amounts of a glass phase may be obtained. Within this window the relative amount of either type of SiAlON is controlled by the Y-content and is nearly temperature independent in the range between 1600 to 1800deg C. Equilibrium is approached closely at 1600deg C after 4 hrs, at T $\geq$ 1700deg C 2 hrs are sufficient. Both α- and β-SiAlON lattice parameters vary with composition. The data indicate a solubility of Y in both types of SiAlON. (orig.).

26146 (LBL–27360) **Anisotropy of grain growth in alumina.** Roedel, J.; Glaeser, A.M. Lawrence Berkeley Lab., CA (USA). Sep 1989. 40p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-890421–12: 91. annual meeting of the American Ceramic Society, Indianapolis, IN (USA), 23-27 Apr 1989). Order Number DE90009045. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Grain growth in theoretically dense undoped and MgO-doped polycrystalline alumina was studied and average grain boundary migration rates were compared to those of a-plane and c-plane sapphire during migration into the same undoped and MgO-doped materials. The results are discussed in terms of a grain size dependent grain boundary mobility grain boundary energy product, $M_b\gamma_b$. The grain size dependencies of the $M_b\gamma_b$ products for seed and matrix grains differ. Seed orientation appears to affect the nature of solute-boundary interactions. The importance of grain boundary structure on migration characteristics is also indicated by a demonstration of twin formation enhanced grain growth. 30 refs., 8 figs., 3 tabs.

26147 (LBL–28194) **In-situ transmission electron microscopy and computer simulation study of the kinetics of oxygen loss in $YBa_2Cu_3O_z$.** Burmester, C.P.; Wille, L.T.; Gronsky, R.; Ahn, B.T.; Lee, V.Y.; Beyers, R.; Gur, T.M.; Huggins, R.A. Lawrence Berkeley Lab., CA (USA). Dec 1989. 4p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-891119–115: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90009221. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

High resolution transmission electron microscopy during in-situ quenching of $YBa_2Cu_3O_z$ is used to study the kinetics of microdomain formation during oxygen loss in this system. Image simulations based on atomic models of oxygen-vacancy order in the basal plane of this material generated by Monte Carlo calculations are used to interpret high resolution micrographs of the structures obtained by quenching. The observed domain structures agree well with those obtained from the simulations. 9 refs., 5 figs.

26148 Occupation of distorted Cu(1) sites by Co and Fe in $Y_1Ba_2Cu_3O_{7-\delta}$. Bridges, F. (Dept. of Physics, Univ. of California, Santa Cruz, CA (US)); Boyce, J.B.; Claeson, T.; Tarascon, J.M.; Geballe, T.H. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

Small perturbations of the structure and composition of the 90K superconductor $Y_1Ba_2Cu_3O_{7-\delta}$ (YBCO) have profound effects on

its superconducting properties. In an effort to understand the interaction between the structure of YBCO and its superconducting properties, the authors made an investigation of YBCO doped with Fe and Co, using x-ray absorption spectroscopy. The EXAFS experiments presented here indicate that some of the Co occupies strongly distorted Cu(1) sites. The results for the Fe substituted samples are similar, but the distortion is less and there appears to be a small occupation of the Cu(2) site as well.

26149 The tensile properties and microstructure of Ti-TiC composites with Al additions. Chen, J. (Oak Ridge National Laboratory, TN (USA)); Geng, Z.; Chin, B.A. pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161--: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The relationship between the tensile properties and microstructure of Ti-TiC composite materials with Al additions was investigated. Composites containing 40-50 percent TiC by volume were produced using standard casting procedures from the melt. Ultimate tensile strengths of 1113 MPa with 1-2 percent ductility were found in these materials. Results show that the tensile properties are controlled by the size and distribution of TiC particles.

26150 The tensile behavior of a Ni_3Al-based composite with TiC reinforcement. Fuchs, G.E. (Oak Ridge National Laboratory, TN (USA)). pp. 794 of High-temperature ordered intermetallic alloys III; Proceedings of the Third Symposium, Boston, MA, Nov. 29-Dec. 1, 1988. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (US) (1989). (CONF-8811161--: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The tensile properties of a powder processed intermetallic matrix composite and a similarly processed matrix alloy were investigated in the temperature range 298-1273 K. The matrix alloy utilized in the study was the advanced nickel-aluminide IC-221 (Ni-16Al-8Cr-1Zr-0.05B). The composites contained 25 vol pct TiC particulate reinforcement. The specific modulus of the composites was 20-30 percent higher than that of typical Ni-base superalloys. The yield strength of the composites were 10-20 percent greater than that of the matrix at all test temperatures. However, the composites exhibited lower ductility than the matrix. SEM fractography revealed that tensile failure occurred at the matrix/particulate interface. However, remnants of the matrix were observed on TiC particles on the fracture surface, suggesting good matrix/particle bonding. The strengths of the composites were very competitive with Ni-base superalloys. 12 refs.

26151 Chemical bonding and electronic instability in molybdenum oxide metals. Whangbo, M.H. (North Carolina State Univ., Raleigh (USA)); Canadell, E. *Accounts of Chemical Research (USA),* 22(11): 375-381 (Nov 1989). DOE Contract FG05-86ER45259.

A number of studies have been carried out on binary and ternary molybdenum oxides because most of them are low-dimensional metals and therefore exhibit interesting physical properties associated with their electronic instabilities. In all molybdenum oxides except for rare-earth bronze $La_2Mo_2O_7$, the average d-electron count on Mo is less than d^1. Thus, in a molybdenum oxide metal containing several nonequivalent Mo atoms per unit cell, only a limited number of Mo atoms may have d electrons and hence be responsible for its metallic character. Consequently, in discussing the structural and electronic properties of molybdenum oxide metals, it is important to analyze how the Mo atoms possessing d electrons can be identified on the basis of their crystal structures, which d orbitals of such Mo atoms contribute to form the highest occupied bands, what kinds of dispersion relations and Fermi surfaces these bands have, and finally, how the Fermi surfaces are related to their electronic instabilities. In the present Account, we discuss both conceptual and practical aspects of those questions and show that the electronic properties of low-dimensional metals possessing large and complex unit cells can be readily understood by analyzing how the nature of their highest occupied bands is related to the crystal structures.

26152 Superconducting gap in Bi-Sr-Ca-Cu-O by high-resolution angle-resolved photoelectron spectroscopy. Olson, C.G. (Iowa State Univ., Ames (USA)); Liu, R.; Yang, A.B.; Lynch, D.W.; Arko, A.J.; List, R.S.; Veal, B.W.; Chang, Y.C.; Jiang, P.Z.; Paulikas, A.P. *Science (Washington, D.C.) (USA),* 245(4919): 731-733 (18 Aug 1989). DOE Contract W-7405-ENG-82;W-31-109-ENG-38.

Detailed studies indicate a superconducting gap in the high-temperature superconductor $Bi_2Sr_2CaCu_2O_8$. Photoemission measurements with high energy and angle resolution isolate the behavior of a single band as it crosses the Fermi level in both the normal and superconducting states, giving support to the Fermi liquid picture. The magnitude of the gap is 24 millielectron volts. 18 refs., 3 figs.

26153 Prediction of new low compressibility solids. Liu, A.Y. (Lawrence Berkeley Lab., CA (USA)); Cohen, M.L. *Science (Washington, D.C.) (USA),* 245(4920): 841-842 (25 Aug 1989). DOE Contract AC03-76SF00098.

An empirical model and an ab initio calculation of the bulk moduli for covalent solids are used to suggest possible new hard materials. The empirical model indicates that hypothetical covalent solids formed between carbon and nitrogen are good candidates for extreme hardness. A prototype system is chosen and a first principles pseudopotential total energy calculation on the system is performed. The results are consistent with the empirical model and show that materials like the prototype can have bulk moduli comparable to or greater than diamond. It may be possible to synthesize such materials in the laboratory. 15 refs., 2 figs.

26154 The axial oxygen atom and superconductivity in $YBa_2Cu_3O_7$. Conradson, S.D. (Los Alamos National Lab., NM (USA)); Raistrick, I.D. *Science (Washington, D.C.) (USA),* 243(4896): 1340-1343 (10 Mar 1989). DOE Contract AC03-82ER13000.

Changes in the copper K-edge x-ray absorption spectrum of $YBa_2Cu_3O_7$ across the critical temperature indicate that, accompanying the superconducting transition, the mean square relative displacement of some fraction of the Cu2-O4 bonds becomes smaller or more harmonic (or both), that there may be a slight increase in the associated Cu1-O4 distance, and that electronic states involving these atom pairs become more atomic-like. If there is an association between the superconductivity and this lattice instability, then the bridging axial oxygen is of central importance in determining the high transition temperature of $YBa_2Cu_3O_7$. Because this structural perturbation will affect the dynamic polarizability of the copper oxygen sublattice, it is consistent with an excitonic pairing mechanism in these materials. 36 refs., 4 figs.

26155 Synthesis of boron nitride ceramics from 2,4,6-triaminoborazine. Narula, C.K. (Univ. of New Mexico, Albuquerque (USA)); Schaeffer, R.; Datye, A.; Paine, R.T. *Inorganic Chemistry (USA),* 28(21): 4053-4055 (18 Oct 1989). DOE Contract FG05-86ER75294.

A method of preparation for boron nitride by deamination of a readily available borazene $[HNB(NMe_2)]_3$ and conversion of the resulting solid polymer to h-BN is described. The ceramic powder obtained at 1200°C was analyzed by transmission electron microscopy and energy-dispersive x-ray analysis. The results indicated crystalline BN with well-defined sharp lattice fringes and an electron-diffraction pattern consistent with the formation of crystalline BN. 19 refs.

26156 Transition-metal-promoted reactions of boron hydrides. 12. Syntheses, polymerizations, and ceramic conversion reactions of b-alkenylborazines. Lynch, A.T. (Univ. of Pennsylvania, Philadelphia (USA)); Sneddon, L.G. *Journal of the American Chemical Society (USA),* 111(16): 6201-6209 (2 Aug 1989).

High yield synthetic routes for the production of new B-alkenylborazines and poly(B-alkenylborazine) polymers and oligomers as well as the use of the poly(B-alkenylborazines) as polymeric precursors to boron nitride ceramics are reported. The syntheses of the B-alkenylborazines are based on the use of transition-metal reagents to activate the B-H bonds of borazine for either alkyne-addition or olefin-dehydrocoupling reactions and are

the first examples of transition-metal-catalyzed reactions of borazine to be reported. Thus, the complexes $RhH(CO)(PPh_3)_3$ and $IrCl(CO)(PPh_3)_2$ were found to activate borazine/alkyne-addition reactions with acetylene, propyne, 1-butyne, and 2-butyne to give the previously unknown B-substituted alkenylborazines, B-(RHC=CR′)-$B_3N_3H_5$ (R,R′ = H, Me, or Et). For reactions employing $RhH(CO)(PPh_3)_3$, typical yields of B-alkenylborazines range from 70 to 85% with the catalyst undergoing 25-50 turnovers an hour. Palladium bromide was found to catalyze the dehydrocoupling reactions of either borazine or N-trimethylborazine with olefins, such as ethylene and propene, to give the corresponding B-alkenyl- and B-alkylborazine products. The B-alkenylborazines were found to readily undergo thermally induced polymerizations to produce insoluble poly(B-alkenylborazines). Soluble, low molecular weight (< 1,500) oligomers were formed when the thermal polymerization reactions were carried out in the presence of additional borazine. It was found that pyrolysis of these polymers yielded ceramic materials with B/N ratios of ~ 1.0 which, depending upon the polymer and pyrolysis conditions, ranged from black, high carbon materials to white, crystalline h-boron nitride. In all cases, the polymer/ceramic conversions were found to take place with both high ceramic and chemical yields.

26157 Ultrafast studies of transition-metal carbonyl reactions in the condensed phase: Solvation of coordinatively unsaturated pentacarbonyls. Lee, M. (Lawrence Berkeley Lab., CA (USA)); Harris, C.B. *Journal of the American Chemical Society (USA)*, 111(24): 8963-8965 (22 Nov 1989).

Recently ultrafast studies on the photodissociation dynamics of transition-metal carbonyls have drawn considerable attention. In the gas phase, electronically excited $Cr(CO)_6$ molecules lose CO, depending on the initial energy content. In liquids, on the other hand, only $Cr(CO)_6 \rightarrow Cr(CO)_5 + CO$ occurs due to fast vibrational relaxation. A solvent molecule (S) is then expected to enter the vacant metal site of $Cr(CO)_5$ to form a complex. In an attempt to understand the solvation dynamics more fully, they carried out picosecond pump-probe measurements in the visible region with the 1-ps time resolution.

26158 Evidence for formation of gaseous methyl radicals in the decomposition of methoxide on oxygen-precovered Mo(110). Serafin, J.G. (Harvard Univ., Cambridge, MA (USA)); Friend, C.M. *Journal of the American Chemical Society (USA)*, 111(24): 8967-8969 (22 Nov 1989). DOE Contract FG02-84ER13289.

Evidence of the unprecedented formation of gaseous methyl radicals from adsorbed methoxide is presented in this study. Previously, surface methoxide has been found to either form formaldehyde or decompose to CO and H_2. The observation of methyl radicals during decomposition of methanol on Mo(110) precovered with atomic oxygen is of significance to the study of the partial oxidation of methane over metal oxide catalysts, since the observed decomposition pathway of methanol is analogous to the reverse of methane oxidation.

3606 Other Materials

Refer also to citation(s) 25539, 25560, 25561, 25577, 25583, 25597, 25611, 25621, 25652, 25653, 25738, 25809, 25836, 25850, 25972, 25978, 26032, 26057, 26068, 26080, 26083, 26250, 26267, 26277, 26288, 26290, 26291, 26293, 26358, 26420, 26425, 26433, 26567, 26638, 26639, 26777, 27225

26159 (AD-A-216209/7/XAB) **Effect of loading on the laser ablation of graphite/epoxy composite material. Master's thesis.** Hamrick, J.L. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Dec 1989. 119p. (AFIT/GAE/ENY-89D-12). Available from NTIS, PC A06/MF A01.

An investigation was conducted to quantify the effect structural loading of a graphite/epoxy member has upon the mass removal rate during laser ablation. An effective heat of ablation (Q*eff=energy absorbed/mass removed) was used as a measure of this efficiency. A simple physical model of the important factors affecting the graphite/simple physical model of the important factors affecting the graphite/epoxy was developed, and predictions were made of the effect of loading on Q*eff. A three-dimensional finite difference heat transfer code was written to predict the temperature distribution in the composite while modeling the orthotropic nature of the thermal conductivity tensor. The effect of thermal and mechanical loads upon the stress distribution in a single fiber was calculated. A hypothesis was formed that fracture of individual fibers, a process linearly dependent upon applied stress, will remove a fraction of the composite independent of the absorption of laser energy.

26160 (CONF-8805106–, pp. 136-143) **Neutron diffraction from sheared d-glycerol: Preliminary studies.** Straty, G.C. (National Bureau of Standards, Boulder, CO (USA)); Hanley, H.J.M. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

The paper reports on the experimental segment of a wide range investigation the nature of complexity in liquids, as manifested by their behavior under mechanical stress. An apparatus constructed for a feasibility study of such behavior is described. Preliminary neutron diffraction measurements of the static structure factor of supercooled liquid glycerol under shear are reported. Data were taken on the SANS facility at NBS in the range $0.02 \leq Q \leq 0.39$ $Å^{-1}$, and on a triple axis spectrometer operating in a two axis diffraction mode for Q equal to 0.8, 1.35, and 3.5 $Å^{-1}$. Comparisons between the sheared data and data for the system at equilibrium are given. The tentative conclusion is that the influence of shear on the structure factor may be strong, but the data are too qualitative for a significant interpretation.

26161 (CONF-8904275–, pp. 6, Paper 2) **Is the end-of-range loops kinetics affected by surface proximity or ion beam recoils distribution.** Ganin, E. (IBM Research Division, Yorktown Heights, NY (USA)); Marwick, A. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The authors studied formation and annihilation of dislocation loops formed beyond the amorphous/crystalline interface after indium and boron dual implantation and subsequent annealing in the 800-1100°C temperature range. The residual damage for low (40 keV) and high (200 keV) energy In implants were compared. The depth of the amorphous region in the sample implanted with the higher energy ions was reduced by using anodic oxidation and etching, to equate it with that of the sample implanted by lower energy ions. This enabled the study of the effect of surface proximity on residual disorder upon annealing. The damage was strongly dependent on the energy of In ions. No end-of-range damage was observed for the low energy implant. High energy implantation resulted in end-of-range dislocation loops, stable below 1050°C. The loops kinetics was neither affected by their proximity to the surface, nor by In precipitation. Monte-Carlo full cascade simulation has been used to estimate the depth distribution of interstitials and vacancies produced by In implant. 9 refs., 4 figs.

26162 (CONF-8904275–, pp. 7, Paper 3) **Shallow junction formation in As-implanted Si by low-temperature rapid thermal annealing.** El-Ghor, M.K.; Pennycook, S.J.; Zuhr, R.A. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Shallow junctions were formed in single-crystal Si(100) by implantation of As at energies between 2 and 17.5 keV followed by conventional furnace annealing or by rapid thermal annealing (RTA). Cross-sectional transmission electron microscopy (XTEM) showed that defect-free shallow junctions could be formed at temperatures as low as 700°C by RTA, with about 60% dopant activation. From a comparison of short-time and long-time annealing, it is proposed that surface image forces are responsible for the efficient removal of end-of-range (EOR) dislocation loops. 25 refs., 5 figs., 1 tab.

26163 (CONF-8904275–, pp. 5, Paper 4) **Damage removal of low energy ion implanted BF_2 layers in silicon.** Myers, E. (North Carolina State Univ., Raleigh (USA)); Hren, J.J.; Hong, S.N.; Ruggles, G.A. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Recent results indicate that thermal budgets associated with ion implantation induced end of range damage removal is affected by the presence of a free surface. Low energy BF_2 implants (6 keV) were done into both single crystal and Ge preamorphized silicon substrates. Rapid thermal processing was used to study the residual end of range defect structure in the temperature range from 700 to 1000°C. 6keV, 5E14 cm^{-2} BF_2 implantation resulted in formation of continuous amorphous layers approximately 10 nm deep with a mean B penetration of approximately 7 nm. Conventional TEM analysis found the structures to be completely free of any spanning hairpin dislocations or stacking faults associated with the BF_2 implant for all the annealing temperatures. For anneals between 700°C and 900°C end of range damage formation resulted, but the size of the dislocation loops remained small. Annealing at 1000°C, 10 seconds showed no evidence of residual end of range damage. Location of the end of range damage region close to the free surface was found to decrease the thermal budget required for the removal of ion implantation induced radiation damage. 10 refs., 3 figs.

26164 (CONF-8904275–, pp. 6, Paper 5) **Removal of end-of-range ion implantation defects in silicon by near noble and refractory silicide formation.** Lur, W. (National Tsing Hua Univ. (China)); Cheng, J.Y.; Chen, L.J. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Complete removal of end-of-range (EOR) defects in ion implanted silicon has been achieved by the formation and growth of near noble silicides ($CoSi_2$ and $NiSi_2$) and refractory silicides ($MoSi_2$ and WSi_2). Continued generation of vacancies during the silicide growth was found to be essential to reduce EOR defects. The results are consistent with the suggestion of the presence of a vacancy diffusion barrier near the EOR defects. 11 refs., 6 figs.

26165 (CONF-8904275–, pp. 6, Paper 6) **Ion induced crystallization and amorphization of silicon.** Jackson, K.A. (AT and T Bell Labs., Murray Hill, NJ (USA)). Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Extensive experimental investigations which have been reported on the ion-induced motion of the interface between the crystalline and amorphous phases of silicon are shown to fit a model based on a single defect. The model accounts for the temperature and flux dependence of the interface motion. The defects annihilate each other by binary recombination, and have a motion energy of 1.2 eV. The defect is believed to be the dangling bond in the amorphous phase. 9 refs., 4 figs.

26166 (CONF-8904275–, pp. 8, Paper 7) **Diffusion, segregation and recrystallization in high-dose ion-implanted Si.** Pennycook, S.J. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Using the new technique of Z-contrast scanning transmission electron microscopy (STEM), the authors have been able to study the segregation of Sb at an advancing SPE growth interface and the resulting interface breakdown. The first direct information is obtained on Sb diffusion in the amorphous phase, which is many orders of magnitude enhanced over tracer crystalline values. This controls both the dopant incorporation and the stability of the resulting supersaturated alloy. These results are compared to the behavior of the low melting point substitutional diffusers and the interstitial diffusers. 23 refs., 8 figs.

26167 (CONF-8904275–, pp. 12, Paper 9) **Reduction of excess self-interstitials in silicon by germanium and silicon implantation-induced damage.** Fahey, P. (IBM Research Division, Yorktown Heights, NY (USA)). Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The author have investigated a phenomena first reported by Pfiester and Griffin, that the presence of implanted Ge in Si can substantially reduce excess self-interstitial concentrations. By studying the effects of Ge implantation on P diffusion, the authors able to deduce that residual implantation damage can act as an efficient sink for self-interstitials. This effect can also be produced by Si self-implantation, demonstrating that there is nothing unique about the chemical identity of Ge in reducing self-interstitial concentrations. The experiments provide solid evidence that there is no unexpectedly strong interaction of Ge with self-interstitials, a situation that would undermine the validity of previous Ge diffusion experiments aimed at studying Si self-diffusion. The experimental results show that the effect of Ge implantation on P diffusion is a complicated function of implantation conditions. Diffusion is affected by the order of the P and Ge implants as well as by changes in implant energies and doses. 18 refs., 5 figs.

26168 (CONF-8904275–, pp. 6, Paper 10) **The ion implanted arsenic tail in silicon.** Beck, S.E. (Lehigh Univ., Bethlehem, PA (USA)); Jaccodine, R.J.; Clark, C. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Rapid thermal annealed tail regions of shallow junction arsenic implants into silicon have been investigated. Tail profiles have been produced by an anodic oxidation and stripping technique after implantation to fluences of 10^{14} to 10^{16} cm^{-2} and by implanting through a layer of silicon dioxide. Electrical activation and diffusion have been achieved by rapid thermal annealing in the temperature range of 800 to 1100°C. Electrically active defects remain after annealing. Spreading resistance and deep level transient spectroscopy results are presented. The diffusion of the arsenic tail is discussed and compared with currently accepted models. 17 refs., 5 figs., 1 tab.

26169 (CONF-8904275–, pp. 6, Paper 11) **Effect of recoil implantation of oxygen on boron enhanced diffusion in silicon.** Fan, D. (Lehigh Univ., Bethlehem, PA (USA)); Jaccodine, R.J. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

In device fabrication, dopants are frequently implanted into silicon through silicon dioxide masks. A consequence of this technique is the co-implantation of recoiled oxygen into the substrate. This study investigates the effect of recoiled oxygen on the widely observed transient enhanced boron diffusion. Comparison of the spreading resistance profiles of annealed through-oxide and directly implanted samples reveals that transient enhanced diffusion of boron can be suppressed by the former process. Continued annealing of the through-oxide implanted silicon recovers the enhanced diffusion of boron. This behavior is believed to be due to precipitation of recoiled oxygen. The mechanisms leading to the above observations are discussed and transmission electron microscopy support presented. 11 refs., 5 figs.

26170 (CONF-8904275–, pp. 6, Paper 12) **Temperature dependence of damage in boron-implanted silicon.** Ottaviani, G. (via Campi 213/A, Modena (Italy)); Nava, F.; Tonini, R.; Frabboni, S.; Cerofolini, G.F.; Cantoni, P. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr

1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The authors have performed a systematic investigation of boron implantation at 30 keV into <100> n-type silicon in the 77-300 K temperature range and mostly at 9×10^{15} cm^{-2} fluence. The analyses have been performed with ion channeling and cross sectional transmission electron microscopy both in as-implanted samples and in samples annealed in vacuum furnace at 500°C and 850°C for 30 min. They confirm the impossibility of amorphization at room temperature and the presence of residual damage mainly located at the boron projected range. On the contrary, a continuous amorphous layer can be obtained for implants at 77 K and 193 K; the thickness of the implanted layer is increased by lowering the temperature, at the same time the amorphous-crystalline interface becomes sharper. Sheet resistance measurements performed after isochronal annealing shows an apparent reverse annealing of the dopant only in the sample implanted at 273 K. The striking differences between light and heavy ions observed at room temperature implantation disappears at 77 K and full recovery with no residual damage of the amorphous layer is observed. 10 refs., 5 figs.

26171 (CONF-8904275–, pp. 6, Paper 13) **Plasma immersion ion implantation for impurity gettering in silicon.** Wong, H. (Univ. of California, Berkeley (USA)); Qian, X.Y.; Carl, D.; Cheung, N.W.; Lieberman, M.A.; Brown, I.G.; Yu, K.M. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The authors have utilized plasma immersion ion implantation (PIII) to demonstrate effective gettering of metallic impurities in silicon wafers. Metallic impurities such as Ni, Cu or Au were intentionally diffused into Si as marker impurities. The Ar or Ne atoms were ionized in an electron cyclotron resonance (ECR) plasma chamber. The ions were accelerated by a negative voltage applied to the wafer and implanted into the wafer. The as-implanted saturation dose can be as high as 5×10^{16} cm^{-2}. After an annealing step at 1000°C for 1 hour in a N_2 ambient, the retained doses and the amount of gettered impurities were measured with Rutherford backscattering spectrometry (RBS). With a retained Ar dose in 10^{15} cm^{-2} range after annealing, the gettered Ni, Cu and Au were 3.0×10^{14} cm^{-2}, 3.0×10^{14} cm^{-2} and 4.4×10^{13} cm^{-2} respectively. 5 refs., 4 figs., 1 tab.

26172 (CONF-8904275–, pp. 10, Paper 14) **Impurity gettering by implanted carbon in silicon.** Wong, H. (Univ. of California, Berkeley (USA)); Cheung, N.W.; Yu, K.M.; Chu, P.K.; Liu, J. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The authors have observed strong gold gettering by implanted carbon in silicon. It was found that the gettering agents in carbon implanted layers are point defects associated with singular carbon atoms. The positions of the gettered Au atoms were found to be distorted substitutional sites. A point-defect gettering model is proposed to explain the findings. 27 refs., 8 figs., 1 tab.

26173 (CONF-8904275–, pp. 6, Paper 15) **Crystal stability and microstructural evolution in polycrystalline Si films during ion irradiation.** Atwater, H.A. (California Institute of Technology, Pasadena (USA)); Brown, W.L. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Amorphous Si is nucleated heterogeneously at grain boundaries during irradiation of polycrystalline Si by 1.5 MeV Xe^+ ions for temperatures of 150-225°C. Following formation at grain boundaries, the amorphous Si layer grows at a rate comparable to the growth rate of a pre-existing amorphous-crystal interface, resulting in a decrease in average grain size and a marked change in the grain size distribution. The heterogeneous nucleation kinetics of amorphous Si are strongly dependent on grain boundary structure. A simple atomistic model for amorphous phase formation, which suggests that the nucleation kinetics are dependent on the point defect mobilities and grain boundary structure, is related to the experimental results. 10 refs., 5 figs., 1 tab.

26174 (CONF-8904275–, pp. 6, Paper 16) **Amorphization and annealing of 6H SiC implanted with N-type, P-type or isovalent dopants.** Spitznagel, J.A. (Westinghouse Science and Technology Center, Pittsburgh, PA (USA)); Wood, S.; Choyke, W.J.; Devaty, R.P.; Ruan, J. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Ions of boron, phosphorus, titanium and neon were implanted into (0001) oriented 6H SiC crystals at 300 K. Implantation energies and fluences were chosen to produce equal (calculated) displacements per atom at similar peak damage depths and a randomized (metaminct or amorphous) zone extending to the front surface. RBS/channeling was used to test the amorphization criteria. Dopant effect on regrowth kinetics and microhardness have been determined by isochronal annealing. 14 refs., 3 figs., 2 tabs.

26175 (CONF-8904275–, pp. 6, Paper 23) **Epitaxial explosive crystallization of amorphous silicon layers buried in a silicon (100) and (111) matrix.** Stolk, P.A. (FOM-Institute for Atomic and Molecular Physics, Amsterdam (Netherlands)); Polman, A.; Sinke, W.C.; Bulle-Lieuwma, C.W.T.; Vandenhoudt, D.E.W. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

420 nm thick amorphous Si layers buried in a Si (100) or Si (111) matrix, produced by 350 keV Si-implantation, were irradiated using a pulsed ruby laser. Time-resolved reflectivity measurements show that melting can be initiated buried in the samples at the crystalline-amorphous interface. Melting is immediately followed by explosive crystallization of the buried amorphous layer, which is started from the crystalline top layer. The velocity of this self-sustained crystallization process is determined to be 15.0 ± 0.5 m/s for Si (100) and 14.0 ± 0.5 m/s for Si (111). RBS and cross-section TEM reveal that epitaxially grown crystalline Si, containing a high density of twin defects, is formed in both the Si (100) and the Si (111) sample. 17 refs., 3 figs.

26176 (CONF-8904275–, pp. 6, Paper 24) **MeV implantation of gallium arsenide.** Kanber, H. (Hughes Aircraft Co., Torrance, CA (USA)); Chen, J.C.; Barger, M.J. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The authors investigated n-type MeV implants into semi-insulating GaAs to fabricate fully implanted varactor diodes for monolithic millimeter-wave applications. Single and multiple implants of Si from 6 to 2.5 MeV and 6 MeV S implants in GaAs were studied before and after capless furnace annealing and rapid thermal annealing by chemical profiling using secondary ion mass spectrometry (SIMS) and electrochemical and traditional differential capacitance-voltage profiling. A buried active layer at a depth of 2.8 μm with a peak carrier concentration of 2.5×10^{18} cm^{-3} was achieved by using 6 MeV Si + 4 MeV Si + 6 MeV S implants and rapid thermal annealing them at a temperature 1050°C for 10 seconds. The chemical profiles are correlated to the electrical profiles to determine activation and annealing behavior of MeV Si and S implants in semi-insulating GaAs. 5 refs., 7 figs. 1 tab.

26177 (CONF-8904275–, pp. 6, Paper 25) **Influence of the temperature of implantation on the morphology of defects in MeV implanted GaAs.** Braunstein, G. (Eastman Kodak Co., Rochester, NY (USA)); Chen, S.; Lee, S.T.; Rajeswaran, G. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA

(USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The authors have studied the influence of the temperature of implantation on the morphology of the defects created during 1-MeV implantation of Si into GaAs, using RBS-channeling and TEM. The annealing behavior of the disorder has also been investigated. Implantation at liquid-nitrogen temperature results in the amorphization of the implanted sample for doses of 2×10^{14} cm^{-2} and larger. Subsequent rapid thermal annealing at 900°C for 10 seconds leads to partial epitaxial regrowth of the amorphous layer. Depending on the implantation dose, the regrowth can proceed from both the front and back ends of the amorphous region or only from the deep end of the implanted zone. Nucleation and growth of a polycrystalline phase occurs concurrently, limiting the extent of the epitaxial regrowth. After implantation at room temperature and above, two distinct types of residual defects are observed or inferred: point defect complexes and dislocation loops. Most of the point defects disappear after rapid thermal annealing at temperatures $\geq$ 700°C. The effect of annealing on the dislocation loops depends on the distance from the surface of the sample. Those in the near surface region disappear upon rapid thermal annealing at 700°C, whereas the loops located deeper in the sample grow in size and begin to anneal out only at temperatures in excess of 900°C. Implantation at temperatures of 200-300°C results in a large reduction in the number of residual point defects. Subsequent annealing at 900°C leads to a nearly defect-free surface region and, underneath that, a buried band of partial dislocation loops similar to those observed in the samples implanted at room temperature and subsequently annealed. 8 refs., 5 figs.

26178 (CONF-8904275–, pp. 6, Paper 28) **Fabrication of high quality silicide layers by ion implantation.** Reeson, K.J. (Univ. of Surrey, Guildford (England)); Gwilliam, R.; Jeynes, C.; Sealy, B.J.; Bussmann, U.; De Veirman, A.; Lindner, J.K.N.; te Kaat, E.H. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Buried layers of $CoSi_2$ have been successfully fabricated in (100) single crystal silicon by implanting 350 keV Co^+ to doses in the range $2\text{-}7 \times 10^{17}$ cm^{-2} at a temperature at $\approx$ 550°C. For doses $\geq 4 \times 10^{17}$ $^{59}Co^+$ cm^{-2}, a continuous buried layer of $CoSi_2$ grows epitaxially, during implantation. After annealing (1000°C 30 minutes) continuous layers of stoichiometric $CoSi_2$, which are coherent with the matrix are produced for doses $\geq 4 \times 10^{17}$ $^{59}Co^+$ cm^{-2}. For doses of $\leq 2 \times 10^{17}$ $^{59}Co^+$ cm^{-2}, discrete octahedral precipitates of monocrystalline $CoSi_2$ are observed. Isochronal annealing (for 5S) at temperatures in the range 800-1200°C, shows that at temperatures $\geq$ 900°C there is significant redistribution of the Co from B-type or interstitial sites $\rightarrow$ substitutional A-type lattice sites. As the anneal temperature is increased there is a corresponding improvement in the crystallinity and coherency of the Si and $CoSi_2$ lattices. This shows that at a given temperature much of the Co redistribution takes place within the first 5s of the anneal. 20 refs., 6 figs.

26179 (CONF-8904275–, pp. 6, Paper 29) **Lateral confinement of silicide layers synthesized with high dose implantation and annealing.** White, A.E. (AT and T Bell Labs., Murray Hill, NJ (USA)); Short, K.T.; Berger, S.D.; Huggins, H.A.; Loretto, D. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Using mesotaxy, a technique which involves high dose implantation followed by high temperature annealing, the authors have created narrow wires of $CoSi_2$ buried beneath the surface of a silicon wafer. The implantation masks are fabricated directly on the silicon substrate using high resolution electron beam lithography in combination with reactive ion etching. TEM analysis shows that the wires are single-crystal and oriented with the substrate with very abrupt interfaces. The electrical continuity of the wires has been confirmed with electron-beam-induced current measurements. 4 refs., 5 figs.

26180 (CONF-8904275–, pp. 6, Paper 30) **Formation of buried iridium silicide layer in silicon by high dose iridium ion implantation.** Yu, K.M. (Lawrence Berkeley Lab., CA (USA)); Katz, B.; Wu, I.C.; Brown, I.G. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The authors have investigated the formation of $IrSi_3$ layers buried in (111) silicon. The layers are formed by iridium ion implantation using a metal vapor vacuum are (MEVVA) high current metal ion source at room temperature with average beam energy $\approx$ 130 keV. Doses of the Ir ions ranging from 2×10^{16} to 1.5×10^{17}/cm^2 were implanted into (111) Si. The formation of $IrSi_3$ phase is realized after annealing at temperatures as low a 500°C. A continuous $IrSi_3$ layer of $\approx$ 200 Å thick buried under $\approx$ 400 Å Si was achieved with samples implanted with doses not less than 3.5×10^{16}/cm^2. Implantated doses above 8×10^{16}/cm^2 resulted in the formation of an $IrSi_3$ layer on the surface due to excessive sputtering of Si by the Ir ions. The effects of implant dose on phase formation, interface morphology and implanted atom redistribution are discussed. Radiation damage and regrowth of Si due to the implantation process was also studied. 16 refs., 6 figs.

26181 (CONF-8904275–, pp. 6, Paper 31) **Back channel degradation and device material improvement by Ge implantation.** Namavar, F. (Spire Corp., Bedford, MA (USA)); Buchanan, B.; Cortesi, E.; Sioshansi, P. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Because of potential back channel leakage problems in silicon-on-insulator (SOI) metal-oxide-semiconductor (MOS) devices, especially n-channel MOS devices which must operate in an ionizing radiation environment, it is desirable to produce Separation by IMplantation of OXygen (SIMOX) wafers which have a layer of poor quality silicon near the Si/buried SiO_2 interface. At the same time, these wafers must have low defect, high quality silicon near the wafer surface for device fabrication. The authors have demonstrated that with Ge ion implantation and solid phase epitaxy regrowth, the surface region of the silicon top layer of the SIMOX wafer is improved and the region adjacent to the buried SiO_2 is degraded. These results have been observed by RBS/channeling, XTEM, and plane view TEM. 16 refs., 4 figs.

26182 (CONF-8904275–, pp. 6, Paper 32) **On the formation of thick and multiple layer SIMOX structures and their applications.** Namavar, F. (Spire Corp., Bedford, MA (USA)); Cortesi, E.; Sioshansi, P.; Soref, R.A. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

This paper will address the formation of SIMOX structures with thick and multiple buried SiO_2 layers by multiple oxygen implantation and growth of epitaxial Si by chemical vapor deposition (CVD). The results indicate that SIMOX material can be produced with a buried layer of any thickness or with any number of distinct buried oxide layers and distinct silicon layers. Thick and double buried SiO_2 layer material may be useful for high voltage isolation and electric field shielding. In addition, the authors have demonstrated optical waveguide action in SIMOX wafers. This suggest that in a double buried SiO_2 layer system, three dimensional stacked integration of silicon waveguides is possible, including two level optical interconnects. 9 refs., 4 figs.

26183 (CONF-8904275–, pp. 6, Paper 33) **Oxygen doped silicon surface layers by ion implantation.** Srikanth, K. (Pennsylvania State Univ., University Park (USA)); Ashok, S. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA

(USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Oxygen doping of silicon with ion implantation has been attempted with the aim of modifying the surface electrical properties of the substrate. The change in current-voltage (I-V) characteristic after 1200°C anneal has been ascribed to the formation of Oxygen Doped Silicon. The independence of the I-V characteristics on the choice of top metal contact and the reversal in direction of rectification strongly suggest the formation of an alloy layer in Si by the implantation. SIMS measurements indicate a sharp oxygen profile after the anneal and FTIR data show that oxygen is in the form of SiO_2 embedded in a silicon matrix. 9 refs., 3 figs.

26184 (CONF-8904275–, pp. 6, Paper 34) **Study of stress and morphology of silicon-on-insulator by means of ultraviolet reflectance spectroscopy.** Lacquet, B.M. (Rand Afrikaans Univ., Johannesburg (South Africa)); Swart, P.L. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

SOI material was prepared by implanting a high dose of nitrogen into crystalline silicon at an energy of 160 keV to form a buried layer of silicon nitride. Ultraviolet reflectance spectroscopy was employed to characterize the material. In the current presentation the isothermal annealing behavior of the surface material was investigated with regard to amorphization and stress. Measured UV-reflectance of the samples are compared to simulated reflectance data which were obtained by presenting the implanted material as a layered structure with the surface layer consisting of a mixed layer of amorphous and crystalline silicon. From these simulations the percentage amorphization at each stage during the annealing cycle is quantitatively determined. Stress is qualitatively determined by considering the shift in the position of the frequencies at which reflectance maxima associated with Van Hove singularities are observed in the ultraviolet range. The annealing cycle used in this work provide to be adequate for returning the material back to single crystal status and relieving the initial stress in this layer. 15 refs., 3 figs.

26185 (CONF-8904275–, pp. 6, Paper 36) **Compensation in GaAs/GaAlAs heterostructures by ion implantation: Comparison of oxygen and boron.** Descouts, B. (Centre National d'Etudes des Telecommunications, Bagneux (France)); Tasselli, J. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Ion implantation has been used to form an insulating layer in GaAs/GaAlAs heterostructures for bipolar transistor applications with the aim of reducing the base-collector capacitance. Two ions have been compared: boron and oxygen. In both cases magnesium has been implanted to contact the base layer and rapid thermal annealing has been used to activate this dopant. It is shown that the base-collector capacitance can be lowered by a factor of ≈ 2 with oxygen, but high oxygen doses ($\geq 10^{14}$ ions/cm^2) are necessary to obtain reproducible results. The capacitance is lowered by a factor of ≈ 4 with optimized boron dose. With high boron doses ($\geq 10^{13}$/cm^2) the capacitance has been decreased by a factor of $\approx$ 6 but the defects created during the implantation affect the properties of the emitter and base layer. 9 refs., 3 figs., 1 tab.

26186 (CONF-8904275–, pp. 6, Paper 37) **Correlation between defect characteristics and layer intermixing in SI implanted GaAs/AlGaAs superlattices.** Chen, S. (Eastman Kodak Co., Rochester, NY (USA)); Lee, S.T.; Braunstein, G.; Rajeswaran, G.; Fellinger, P. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Defects induced by ion implantation and subsequent annealing are found to either promote or suppress layer intermixing in III-V compound semiconductor superlattices (SLs). The authors have studied this intriguing relationship by examining how implantation and annealing conditions affect defect creation and their relevance to intermixing. Layer intermixing has been induced in SLs implanted with 220 keV Si$^+$ at doses $> 1 \times 10^{14}$ ions/cm^2 and annealed at 850°C for 3 hrs or 1050°C for 10 s. Upon furnace annealing, significant Si in-diffusion is observed over the entire intermixed region, but with rapid thermal annealing layer intermixing is accompanied by negligible Si movement. TEM showed that the totally intermixed layers are centered around a buried band of secondary defects and below the Si peak position. In the near-surface region layer intermixing is suppressed and is only partially completed at $\geq 1 \times 10^{15}$ Si/cm^2. This inhibition is correlated to a loss of the mobile implantation-induced defects, which are responsible for intermixing. 22 refs., 3 figs.

26187 (CONF-8904275–, pp. 6, Paper 38) **Implant damage in AlGaAs based superlattices and alloys at 77K.** Dobisz, E.A. (Naval Research Lab., Washington, DC (USA)); Dietrich, H.; McCormick, A.W.; Harbison, J.P. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Previously, it was shown that superlattices implanted with Si at 77K, exhibited more extensive damage and uniform compositional mixing upon subsequent annealing than samples implanted at room temperature. The current work focuses on the damage in samples implanted with Si at 77K. The study shows that for a given dose, the amount of damage depends upon the layer thickness and the composition. Specimens of bulk GaAs, $Al_{.3}Ga_{.7}As$, 7.5 nm GaAs - 10 nm $Al_{.3}Ga_{.7}As$ superlattice (SL1), 5.5 nm GaAs $\approx$3.5 nm AlAs superlattice (SL2), and 8.0 nm GaAs - 8.0 nm AlAs superlattice (SL3) were implanted at 77 K with 100 KeV Si, with doses ranging from 3×10^{13} cm^{-2} to 1×10^{15} cm^{-2}. The samples were examined by ion channeling and cross sectional transmission electron microscopy (TEM). At 77K and a dose of 1×10^{14} cm^{-2}, the GaAs and SL1 showed an amorphous layer, while no damage peak was observed in SL2. The 77K amorphization thresholds of the $Al_{.3}Ga_{.7}As$ alloy, SL2, and SL3 were 2.5×10^{14} cm^{-2}, 4×10^{14} cm^{-2}, and 1×10^{15} cm^{-2} respectively. The sharpness of the amorphization threshold varied with the material. 12 refs., 6 figs., 1 tab.

26188 (CONF-8904275–, pp. 6, Paper 39) **Enhanced interdiffusion of GaAs-AlGaAs interfaces following ion implantation and rapid thermal annealing.** Kahen, K.B. (Eastman Kodak Co., Rochester, NY (USA)); Rajeswaran, G.; Peterson, D.L.; Zheng, L.R.; Ott, M.L. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The interdiffusion of GaAs-AlGaAs interfaces has been shown to be enhanced following ion implantation and rapid thermal annealing at approximately 950°C. A model is presented which explains this phenomenon. It is based on the solution of coupled diffusion equations involving the excess vacancy and Al distributions following ion implantation. Both initial distributions are obtained from the solution of a three-dimensional Monte Carlo simulation of ion implantation into a heterostructure sample. The model is found to be in excellent agreement with several sets of experimental data. More specifically, the model is shown to be valid for ions which do not diffuse appreciably in the time frame of the rapid thermal annealing and for as-implanted vacancy concentrations below $\approx 6 \times 10^{19}$ cm^{-3}. Above that concentration, some vacancies are hypothesized to coalesce, thus being unavailable to assist in the enhanced interdiffusion process. 14 refs., 4 figs.

26189 (CONF-8904275–, pp. 5, Paper 42) **New features of dark and photoconductivity response of low energy Ar$^+$ ion bombarded GaAs.** Vaseashta, A. (Virginia Polytechnic Institute and State Univ., Blacksburg (USA)); Burton, L.C. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA

(USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Photoconductivity measurements have been made on three SI GaAs sample types: Ar^+ ion etched at 1eV, 3keV, and unetched. Measurements were made versus time, wavelength, and temperature. Photoquenching was done at 1.19 and 2.OeV energy. Some distinct changes in photoconductive properties are caused by the ion etch: (1) Increase in dark resistance; (2) presence of persistent photoconductivity; (3) increased photosensitivity; (4) increase in quenching rate under 2eV illumination; (5) destruction of the 0.47eV thermally activated photoconductivity. All samples exhibit Shockley-Read recombination controlled photoconductivity below a temperature of 125K, with the same apparent trap location, at 0.26eV above E_F. 16 refs., 4 figs.

26190 (CONF-8904275–, pp. 6, Paper 43) **Shallow doping of gallium arsenide by recoil implantation.** Sadana, D.K. (IBM T.J. Watson Research Center, Yorktown Heights, NY (USA)); de Souza, J.P.; Rutz, R.F.; Cardone, F.; Norcott, M.H. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Si atoms were recoil-implanted into GaAs by bombarding neutral (As^*) or dopant (Si^*) ions through a thin Si cap. The bombarded samples were subsequently rapid thermally or furnace annealed at 815-1000°C in Ar or arsine ambient. The presence of the recoiled Si in GaAs and resulting n^+-doping was confirmed by secondary ion mass spectrometry and Hall measurements. It was found that sheet resistance of $< 150\ \Omega/\{$ open_square$\}$ can be achieved by this method. Capless furnace annealing in arsine ambient generally yielded better electrical results (especially for shallow implants, i.e., < 100 nm deep) compared to those obtained by RTA in an inert ambient with a Si cap. In the latter case, electrical activation deteriorated above 900°C due to high As loss and the deterioration was pronounced for shallow implants. Significant Si redistribution occurred during arsine annealing whenever the Si concentration (from recoil or direct implants) in GaAs exceeded $1 \times 10^{19}cm^3$ and the annealing temperature was > 850°C. The present electrical data show that the recoil implant method is a viable alternative to direct shallow implant for n^+ doping of GaAs. 7 refs., 3 figs., 1 tab.

26191 (CONF-8904275–, pp. 6, Paper 45) **Dual ion implantations of Si + As and S + As into GaAs.** Fan, W.D. (Shanghai Institute of Metallurgy (China)); Wang, W.Y.; Zhou, B.L. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

As^+ implantation has been used to compensate the As loss during annealing for Si- or S-implanted GaAs. The As^+ implantation was at an energy range of 25-100 KeV to a dose range of 10^{12}-$10^{15}cm^{-2}$. The Si^+ or S^+ implantation was at 150 or 50 KeV respectively to the same dose, $2 \times 10^{13}cm^{-2}$. By using the measurements of the Hall effect and sheet resistivity, the activation efficiency and mobility of the dually implanted sample with Si^+ and As^+ (25 KeV, $1 \times 10^{13}cm^{-2}$) after TA at 1050°C for 6s increase by 21 and 18% respectively over those of the singly Si-implanted sample with Si^+ and As^+ (100 KeV, $1 \times 10^{13}cm^{-2}$) increase by 63 ant 30% respectively over those of the singly Si-implanted sample after FA at 800°C for 30 min. Also, the density of Si_{As} and V_{Ga} determined by 20K PL spectra decreases of dually Si- and As-implanted samples. The activation efficiency and mobility of the dually implanted sample with S^+ and As^+ (40 KeV, $1 \times 10^{13}cm^{-2}$) after TA at 1100°C for 12s increase by 18 and 16% respectively over those the singly S- implanted sample. The annealing behavior after As^+ implantation is discussed. 9 refs., 7 figs.

26192 (CONF-8904275–, pp. 6, Paper 46) **Ion implantation into InP/InGaAs heterostructures grown by MOVPE.** Haeussler, W. (Siemens Research Labs., Muenchen (Germany, F.R.)); Walter, J.W.; Mueller, J. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Annealing of Beryllium implantations into epitaxial InP/InGaAs heterostructures was investigated. Different ion energies were used to position the profile maximum in the InP cap, at the heterointerface, or in the underlying InGaAs layer. By measuring the Be atom and carrier profiles, it is shown that annealing conditions necessary for optimum Be activation in the InP cap layer are compatible with good profile control for Be in InGaAs. There is a slight transfer of Be across the interface during annealing, which is important, if the pn-junction is intended to be close to the heterointerface. 14 refs., 5 figs.

26193 (CONF-8904275–, pp. 6, Paper 47) **Observation of the wurtzite phase in OMVPE grown ZnSe/GaAs: Effect on implantation and rapid thermal annealing.** Jones, K.S. (Univ. of Florida, Gainesville (USA)); Yu, J.; Lowen, P.D.; Kisker, D. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Transmission electron diffraction patterns of cross-sectional TEM samples of OMVPE ZnSe and GaAs indicate the existence of the hexagonal wurtzite phase in the epitaxial layers. The orientation relationship is (0002)//(111); (1120)//(220). Etching studies indicate the phase is internal not ion milling induced The average wurtzite particle size is 80 Å-120 Å. Because of interplanar spacing matches it is easily overlooked. Electrical property measurements show a high resistivity ($10^{10}\Omega$/square) which drops by four orders of magnitude upon rapid thermal annealing between 700°C and 900°C for 3 sec. Implantation of Li and N have little effect on the electrical transport properties. The Li is shown to have a high diffusivity, a solid solubility of $\approx 10^{16}/cm^3$ at 800°C and getters to the ZnSe/GaAs interface. 12 refs., 6 figs.

26194 (CONF-8904275–, pp. 6, Paper 48) **Si ion implantation in AlAs/InGaAs heterostructures.** Descouts, B. (Centre National d'Etudes des Telecommunications, Bagneux (France)); Duhamel, N.; Rao, E.V.K.; Gao, Y.; Praseuth, J.P. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Si^{29} implants have been performed in InGaAs and InAlAs single layers as well as in InGaAs/InAlAs heterostructures. Nearly 100% activation has been obtained in InGaAs after conventional furnace annealing or rapid thermal annealing. On the other hand, a low activation efficiency (30%) has been observed in InAlAs. A preliminary photoluminescence measurements study shows that an appreciable fraction of Si exists in the form of complex centers. Hall effect and specific contact resistivity maps carried out in the heterostructures indicate a very good homogeneity of the electrical parameters over a 4 cm^2 sample and give a satisfactory value of the specific contact resistivity ($10^{-7}\ \Omega cm^2$). 15 refs., 6 figs.

26195 (CONF-8904275–, pp. 6, Paper 49) **Studies on phosphorus-implantation and the annealing of cadmium telluride and copper indium disulfide.** Hsu, Y.J. (National Tsing Hua Univ., Taiwan (China)); Hwang, H.L.; Ueng, H.Y. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The doping efficiencies obtained in phosphorus-implanted cadmium telluride and copper indium disulfide annealed by pulse electron beam were higher than those annealed by conventional thermal method. To get insights into this phenomenon, electron paramagnetic resonance measurements were performed for both crystals at various stages during the doping process. The results indicated that the pulse electron beam annealing could effectively eliminate the phosphorus interstitials in the implanted crystals but the thermal annealing could not. This shows the significant effect of

melting crystals by pulse electron beam annealing to obtain high doping efficiencies. 13 refs., 5 figs.

26196 (CONF-8904275–, pp. 11, Paper 52) **Ultra-pure processing: A key challenge for ion implantation processing for fabrication of ULSI devices.** Current, M.I. (Applied Materials, Santa Clara, CA (USA)); Larson, L.A. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

A key issue in modern ion implantation processing is the requirement for dramatic improvements in the purity of the incident ion beam and reductions in the deposition of foreign materials onto the water surface. These deposited materials include particles as well as sputtered and vapor deposited metals and dopants. Physical mechanisms which effect the elemental purity of atoms arriving at the surface of ion implanted wafers and progress towards achieving implantation purity levels of below 100 ppm of the implanted dose for sputtered metal and dopant films are discussed. 24 refs., 9 figs.

26197 (CONF-8904275–, pp. 8, Paper 53) **Electronic properties of ion implanted polymer films.** Giedd, R.E. (Missouri State Univ., Springfield (USA)); Shipman, J.; Murphy, M. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The authors have implanted a number of insulating polymer (PET) thick films with fluences in the range 1×10^{13} to 5×10^{17} ions/cm^2 in order to induce electronic activity. Finite electrical conductivities were obtained for fluences as low as 3×10^{15} ions/cm^2. The resistivity for these implanted materials increases with decreasing temperature demonstrating highly disordered or semiconducting behavior. Hall effect measurements confirm this result and indicate negatively charged carriers with a carrier density of 1.44×10^{17} cm^{-3} for an important dose of 1×10^{17} ions/cm^2. The conductivities also seem to be dependent on the implanted ion species. They believe this material will be useful as an accurate temperature sensor near room temperature. 10 refs., 4 figs.

26198 (CONF-8904275–, pp. 6, Paper 8) **Lattice strain from holes in heavily doped Si:Ga.** Kavanagh, K.L. (Univ. of California, San Diego (USA)); Chang, J.C.P.; Cargill, G.S. III; Boehme, R.F. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Heavily doped Si:Ga has been prepared by liquid phase epitaxy (LPE) and by ion-implantation with rapid thermal annealing (RTA) or laser annealing (LA). Peak substitutional Ga concentrations obtained by each technique were 1.5, 2.5 and 2.9×10^{20} cm^{-3}, respectively. Substitutional fractions (> 90%) were similar in the three types of substitutional Ga atom in Si of $+0.9 \pm 0.1 \times 10^{-24}$ cm^3/atom was measured by double crystal x-ray diffraction. The average nearest neighbor Si-Ga bond length measured with extended x-ray absorption fine structure (EXAFS) was 0.237 ± 0.004 nm, indistinguishable, to within experimental error, from the intrinsic Si-Si bond length, 0.235 nm, indistinguishable, to within experimental error, from the intrinsic Si-Si bond length, 0.235 nm. Combining these two results the lattice strain per hole in the Si valence band was calculated, $+0.4 \pm 0.8 \times 10^{-24}$ cm^3. This result complements the lattice contraction per electron in the Si conduction band ($-1.8 \pm 0.4 \times 10^{-24}$ cm^3) already reported for Si:As. 15 refs., 4 figs., 1 tab.

26199 (CONF-8904275–, pp. 6, Paper 17) **In-situ reflectance measurements of semiconductors during ion implantation.** Swart, P.L. (Rand Afrikaans Univ., Johannesburg (South Africa)); Lacquet, B.M.; Grobler, M.F. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Damage introduced during ion implantation of semiconductor materials coalesce at a certain critical dose, for a particular energy and ion species. After this threshold dose rapid changes occur in the reflectance. This may be used for studying the amorphization process, or it may be applied as a non-destructive dosimeter and uniformity tool. An automated reflectometer was developed for studying reflectance during ion implantation of semiconductors with various ion species. Results on argon and phosphorus implants into silicon at energies ranging from 50 to 240 keV are presented. 23 refs., 4 figs.

26200 (CONF-8904275–, pp. 11, Paper 19) **Lattice defects generated by ion implantation into submicron Si areas.** Tamura, M. (Hitachi, Ltd., Tokyo (Japan)); Shukuri, S.; Kawamoto, Y. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Cross-sectional transmission electron microscopy observations have been carried out to clarify two-dimensional depth distributions of lattice defects generated in high-dose (5×10^{15} ions/cm^2), P, As, BF_2 and B implanted, annealed submicron Si areas as a function of implantation areas. Monte Carlo simulation is also adapted for ion-implantation into submicron Si through fine mask patterns to predict the effect of mask size on spatial damage and impurity profiles. Simulation results predict that the above profiles have a strong mask size dependence for regions below the critical size, where the dopant concentration decreases and damage depth moves toward the surface-side with a reduced implantation area. Some experimental results support simulation results, although most defects, mainly in the P and As implantation, are confined within the original amorphized layers, independent of mask size. However, in BF_2 and B implantation, unexpected defect behavior such as variations in defect distribution from one implanted layer to another is found to occur in submicron regions doped by implantation. 13 refs., 13 figs., 1 tab.

26201 (CONF-8904275–, pp. 6, Paper 21) **Broad and focused ion beams Ga$^+$ implantation damage in the fabrication of p$^+$-n Si shallow junctions.** Steckl, A.J. (Univ. of Cincinnati, OH (USA)); Lin, C.M.; Patrizio, D.; Rai, A.K.; Pronko, P.P. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The use of focused and broad beam Ga$^+$ implantation for the fabrication of p$^+$-n Si shallow junctions is explored. In particular, the issue of ion induced damage and its effect on diode electrical properties is explored. FIB-fabricated junctions exhibit a deeper junction with lower sheet resistance and higher leakage current than the BB-implanted diodes. TEM analysis exhibits similar amorphization and recrystallization behavior for both implantation techniques with the BB case generating a higher dislocation loop density after a 900°C anneal. 6 refs., 5 figs., 1 tab.

26202 (CONF-8904275–, pp. 10, Paper 22) **Damage growth in Si during self-ion irradiation. A study of ion effects over an extended energy range.** Holland, G.W.; El-Ghor, M.K.; White, C.W. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Damage nucleation/growth in single-crystal Si during ion irradiation is discussed. For MeV ions, the rate of growth as was well as the damage morphology are shown to vary widely along the track of the ion. This is attributed to a change in the dominant, defect-related reactions as the ion penetrates the crystal. The nature of these reactions were elucidated by studying the interaction of MeV ions with different types of defects. The defects were introduced into the Si crystal prior to high-energy irradiation by self-ion implantation at a medium energy (100 keV). Varied damage morphologies were produced by implanting different ion fluences. Electron microscopy and ion-channeling measurements, in conjunction with

annealing studies, were used to characterize the damage. Subtle changes in the predamage morphology are shown to result in markedly different responses to the high-energy irradiation, ranging from complete annealing of the damage to rapid growth. These divergent responses occur over a narrow range of dose (2-3 x 10^{14} cm^{-2}) of the medium-energy ions; this range also marks a transition in the growth behavior of the damage during the predamaging implantation. A model is proposed which accounts for these observations and provides insight into ion-induced growth of amorphous layers in Si and the role of the amorphous/crystalline interface in this process. 15 refs., 9 figs.

26203 (CONF-8904275–, pp. 6, Paper 26) **Defects products by high energy oxygen ions implanted in silicon.** Grob, A. (Centre de Recherches Nucleaires, Strasbourg (France)); Grob, J.J.; Thevenin, P.; Siffert, P.; Perio, A. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Rutherford backscattering/channeling analysis was used to study the damage creation processes occurring during 1 MeV O^+ implantation in silicon. The target temperature was varied from RT to 500°C using beam heating. The corresponding damage profiles and dechanneling behavior were studied. Several implantations were performed at 77K for comparison. Transmission electron microscopy observations were connected to the dechanneling measurements in order to determine the dominant kind of defect in each case. For 77K implants, the defects are mainly interstitials distributed according the energy deposition in elastic collisions, extending up to the surface. At 500°C, the defects are imperfect dislocations confined in a narrow band around the mean range of oxygen ions. The authors demonstrate that dechanneling in samples implanted at intermediate temperatures results from a mixing of point defects and distortion centers. The relative importance of the two kind of defects is followed as a function of implantation temperature. 24 refs., 8 figs.

26204 (CONF-8904275–, pp. 12, Paper 35) **Ion implantation processing of GaAs and related compounds.** Pearton, S.J. (AT and T Bell Labs. Murray Hill, NJ (USA)); Hobson, W.S.; Abernathy, C.R. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The formation of doped or semi-insulating layers by ion implantation in both Ga- and In- based semiconductors is reviewed. The Ga-based materials (GaAs, AlGaAs, GaP, GaSb) tend to show similar characteristics in terms of producing relatively low ($n \leq 3 \times 10^{18}$ cm^{-3}) maximum carrier densities for donor implanted layers, and much higher values for acceptor implants ($p \leq 5 \times 10^{19}$ cm^{-3}). Ion-induced damage is widely used for device isolation in these materials, with midgap levels associated with the damage trapping free carriers and leading to semi-insulating behavior. By contrast, the In-based materials (InP, InAs, InSb and InGaAs) show higher maximum carrier densities for acceptor implants than for donor implants, and the use of ion damage for isolation purposes is much less effective than in GaAs. All of these materials display singularly poor regrowth characteristics, requiring in some cases the use of elevated temperature implantation to prevent amorphization. 27 refs., 10 figs., 3 tabs.

26205 (CONF-8904275–, pp. 6, Paper 40) **Ion beam mixing of GaAs/AlGaAs superlattice and its relationship to amorphization.** Pronko, P.P. (Universal Energy Systems, Inc., Dayton, OH (USA)); McCormick, A.W.; Patrizio, D.B.; Rai, A.K.; Kolbas, R.M.; Frank, B.S. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

This work is part of a study to understand the process by which energetic ion bombardment can be used to mix the chemical components of AlGaAs and GaAs superlattice (S/L) layers of nominal 35 to 50 Å thickness. Data reported here involve the retention and build-up of collision cascade damage in the S/L and its relationship to amorphization and chemical mixing in these systems. 8 refs., 6 figs.

26206 (CONF-8904275–, pp. 6, Paper 41) **Effects of helium ion implantation on the optical and crystal properties of GaAs.** Bowman, R.C. Jr. (Aerospace Corp., Los Angeles, CA (USA)); Adams, P.M.; Knudsen, J.F.; Moss, S.C.; Dafesh, P.A.; Smith, D.D.; Ward, I.D.; Herman, M.H. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The damage to GaAs crystals caused by helium ion implants has been monitored by changes in the Raman scattering phonon modes, double-crystal x-ray diffraction rocking curves photoreflectance (PR), and electron beam electroreflectance (EBER) band edge transitions. As the implanted helium ion dose was increased, the various techniques revealed threshold damage behavior at very different levels. Although PR and EBER were the most sensitive to the defects created at the lowest ion doses, all techniques indicated substantial disorder for implants greater than 10^{14} ions/cm^2. 13 refs., 5 figs., 1 tab.

26207 (CONF-8904275–, pp. 6, Paper 44) **Molecular ion S_2^+ and SiF_n^+ implantations into GaAs.** Fan, W.D. (Shanghai Institute of Metallurgy (China)); Wang, W.Y. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Molecular ion S_2^+ and SiF_n^+ implantations into GaAs have been investigated to form very thin active layers. After implantation, the transient annealing (TA) and furnace annealing (FA) were used. The measurements of activation efficiency, mobility, carrier concentration profiles and PL spectra were carried out. The experiments show that after TA, the activation efficiency, mobility and carrier distribution are almost the same between samples implanted with S^+ at an energy of 50KeV to a dose of 3 x $10^{13}cm^{-2}$ and S_2^+ at 100KeV to 1.5 x $10^{13}cm^{-2}$. It shows that the damage of S_2-implanted samples can be removed by TA, and a very thin active layer can be formed by the implantation of S_2^+ at 50KeV. For SiF_n-implanted samples, the activation efficiency and mobility decrease with increase of the implanted ion mass. As^+ co-implantation into SiF-implanted samples has been used to improve both activation efficiency and mobility. After comparison with the properties of the SiF_n^+ implantation, S_2^+ implantation is more acceptable to form thin active layers. 8 refs., 6 figs.

26208 (CONF-8904275–, pp. 5, Paper 54) **SIMS determination of MG^+ and As^+ range profiles in photoresist and polyimide implant masks.** Dugger, D.L. (GTE Labs., Inc., Waltham, MA (USA)); Stern, M.B.; Rubico, T.M. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The distribution of Mg^+ (a p-type dopant for GaAs) and As^+ (an n-type dopant for Si) implanted into both photoresist (PR) and polyimide (PI) have been determined experimentally. Range data of Mg ions at 200 keV and 300 keV and As ions at 150 keV have been measured by Secondary Ion mass Spectroscopy (SIMS). SIMS values for the projected range Rp and the standard deviation ΔRp were compared to range profile data calculated using the Projected Range Algorithm (PRAL) of Biersack (1) as well as the standard LSS theory (2). While the values for Rp calculated from the PRAL model generally agreed within 10% of the SIMS values, the calculations underestimated Rp for PR but were in good agreement for PI. The LSS calculations underestimated Rp in both materials. 6 refs., 2 tabs.

26209 (DOE/ER/45366–2) **The structural basis for fatigue initiation in glassy polymers: Progress report No. 2.** Yee, A.F. (Michigan Univ., Ann Arbor, MI (USA). Dept. of Materials Science and Engineering); Gidley, D.W. Michigan Univ., Ann Arbor, MI

(USA). Mar 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER45366. Order Number DE90009342. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Glassy polymers are often subjected to cyclic loading and consequent failure in energy-related applications. At high amplitudes of loading they fail by ductile deformation, while at intermediate amplitudes the failures are brittle. In the latter case a large fraction of the useful lifetime is spent in the incubation period. Our research is aimed at understanding this initiation process. Since much of the behavior including embrittlement observed in preliminary experiments are similar to those found in physical aging of glassy polymers, some of the techniques used for studying physical aging are also employed here; viz., DSC, stress relaxation, and positron annihilation lifetime studies (PAT). Glassy polycarbonate is used throughout. 4 figs.

26210 (ENEA-RT-TIB–89-26) **Laser assisted synthesis of ultrafine silicon powder.** Borsella, E.; Fantoni, R.; Piccirillo, S.; Nannetti, C.A.; Ceccato, R.; Enzo, S. ENEA, Frascati (Italy). Dipt. Tecnologie Intersettoriali di Base. Sep 1989. 16p. (CONF-890580–1: Symposium on beam processing and laser chemistry, Strasbourg (France), 30 May - 2 jun 1989). Order Number DE90764309. Available from NTIS (US Sales Only), PC A03/MF A01.

Paper presented at the E-MRS symposium D-beam processing and laser chemistry (Strasbourg, 30 May-6 Jun 1989).

Ultrafine Si powder was produced by means of carbon dioxide laser assisted decomposition of silicon hydride. Optical on-line diagnostics (chemiluminescence spectrum collection) and final product analysis were employed in order to establish both gas-phase precursor dissociation and particle growth mechanisms. Morphologic and crystallographic characterizations of the powder were performed. Nitridation of the Si powder was accomplished during sintering. Results were compared with those obtained by direct laser induced photosynthesis of silicon nitride powder.

26211 (ENEA-RT-TIB–89-43) **Diffraction spectra analysis of partially amorphous metallic alloys. Part 2. Separation of domain and distortion contributions according to Warren and Averbach.** Padella, F.; Ennas, G.; Magini, M.; Enzo, S. ENEA, Casaccia (Italy). Dipt. Tecnologie Intersettoriali di Base; Venice Univ. (Italy). Oct 1989. 22p. (In Italian). (RT/TIB–89-43). Order Number DE90764314. Available from NTIS (US Sales Only), PC A03/MF A01.

The production of amorphous metal alloys, or metallic glasses (i.e. $FeZr_2$, $Pd_{75}Si_{25}$), by use of the melt spinning (involving rapid quenching) or mechanical alloying methods does not always allow the obtaining of totally amorphous alloys. Relevant to the determination of the percentage of crystaline phase, a Fortran 4 computer program was developed in order to separate the diffraction domain contribution from lattice distortion. Theoretical principles (Warren and Averbache), as well as the program flowsheet, are described. Particular attention is devoted to the 'true profile' determination by the analytical deconvolution of the instrumental broadening from the experimental profiles. The elaboration, by the WAXS program, of x-ray diffraction data allows the determination of both the average size of the cristallites or the 'strain' present in a determinate phase under intestigation.

26212 (Juel-Conf–77, pp. 149-159) **Influence of precursor prehistory on carbon fibre characteristics.** Spaseka, D. (Skopje Univ. (Yugoslavia). Tehnolosko-Metalurski Fakultet). Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

In this work the influence of precursor (polyacrylonitrile-PAN fibres) characteristics on the obtained carbon characteristics is described. Three types of precursors were used having different characteristics reflecting the prehistory of their production. The first stage of carbon fibres production is mainly responsible for the characteristics of the final product, hence special attention was payed to the investigation of the oxidation and cyclization of PAN fibres. To derive a mathematical relationship which correlates the most important parameters of the thermal treatment process, the experimental planning method has been used. The characteristics of the obtained carbon fibres indicate that a good choice of the precursors as well as of parameters of thermal treatment process was finally made. (orig.).

26213 (Juel-Conf–77, pp. 221-235) **Mechanical alloying for development of sintered steels with high hard phase content.** Fetahagic, A. (Karlsruhe Univ. (T.H.) (Germany, F.R.)); Gutsfeld, C.; Thuemmler, F. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

Sintered steels with 10-30 vol% of disperse transition metal carbides have been developed using mechanical alloying, pressing and liquid phase sintering. The importance of mechanical alloying itself and of several process parameters was evaluated for these new group of sintered steels (in this paper: Fe-10vol%NbC-0.6P). The best results for mechanical properties and microstructure have been achieved by mechanical alloying for short attrition times. In order to press and sinter these materials heat treatment under hydrogen atmosphere before consolidation is necessary to reduce oxygen content and the cold hardening of the mechanical alloyed powders. The large improvement of the material properties through mechanical alloying can be explained by the better carbide distribution, higher sintered densities, smaller grain sizes and better mechanical clasping of these carbides in the steel matrix. (orig./MM).

26214 (Juel-Conf–77, pp. 251-260) **Growth and microstructural development of melt-oxidation derived Al_2O_3/Al-base composites.** Sindel, M. (Technische Univ. Hamburg-Harburg, Hamburg (Germany, F.R.)); Claussen, N. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

The microstructural evolution of an Al_2O_3/Al composite grown from the molten metal surface either into free space or into a filler material is discussed. The filler materials to be 'infiltrated' were different α-Al_2O_3 powders, Al_2O_3 fibers, SiC particles and SiC whiskers. The matrix formation mechanism and the reaction kinetics are discussed with respect to reaction temperature and filler type. The microstructure of matrix and matrix-filler composites is presented and K_{IC} and fracture strength, are given. (orig.).

26215 (Juel-Conf–77, pp. 261-282) **Fabrication of RBSN composites.** Janssen, R. (Technische Univ. Hamburg-Harburg, Hamburg (Germany, F.R.)); Claussen, N. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

The aim of this work is to investigate the degradation mechanism of the most promising components for reinforcing RBSN (SiC, B_4C, TiB_2) under reaction bonding conditions. SiC can be used as reinforcing component for RBSN without critical decomposition of SiC due to the protective effect of surface SiO_2, however, certain conditions must be fulfilled. Decomposition mainly depends on the thickness of SiO_2 on Si and SiC surfaces, on the O_2 amount of nitriding atmosphere and on nitridation conditions. The use of B_4C and TiB_2 as reinforcing material is limited due to a reaction with the gas phase during nitridation. The mechanical properties of RBSN - SiC composites are controlled by the occurrence of a

macropores at high nitridation temperatures. Composites containing sintering additives shows a toughness increase when large platelets are added. (orig./MM).

26216 (Juel-Conf–77, pp. 369-382) **Solid state investigation of ceramic-metal interface bonding.** Jauch, U. (Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl Glas und Keramik und Inst. fuer Gesteinshuettenkunde); Ondracek, G. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

Cermets are a potential class of composites, in which, however, the question of bonding at the ceramic-metal interface plays a key role: non bonding reduces the composite with respect to properties as Young's modulus, electrical conductivity or thermal expansion to those of the porous matrix phase material. This is why a new dilatometric technique is used to study the bonding between ceramic and metal phases selected to produce cermets. The phases used as an example are aluminiumtitanate eutectic and nickel, the method is based on the effect, - that before debonding the measured effective thermal expansion coefficient of the composite lies between the thermal expansion coefficients of its phases; - that after debonding the effective thermal expansion coefficient drops to that of the matrix phase. (orig.).

26217 (LA-UR–90-813) **Rigid rod molecules as liquid crystal thermosets (LCT's).** Hoyt, A.E. (Los Alamos National Lab., NM (USA)); Benicewicz, B.; Huang, S.J. Los Alamos National Lab., NM (USA). [1990]. 16p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Contract N00014-86-K-072. (CONF-900184–1: American Chemical Society symposium on advances in liquid crystalline polymers, Ventura, CA (USA), 2-6 Jan 1990). Order Number DE90008942. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Rigid rod molecules endcapped with conventional crosslinking groups such as maleimide and nadimide were prepared and studied by differential scanning calorimetry and hot stage polarized light microscopy. Nematic liquid crystalline phases were identified in several of the new monomers. Thermally induced polymerization occurred in the nematic phase region and resulted in retention of the nematic texture in the final crosslinked solid. In many cases, isotropization was not observed at normal heating rates due to crosslinking and solidification in the nematic phase. 19 refs., 5 figs., 2 tabs.

26218 (LBL–28514) **Electrical conduction and corrosion processes in fast ion conducting glasses: Final report.** Tuller, H.L. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Materials Science and Engineering). Lawrence Berkeley Lab., CA (USA); Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Materials Science and Engineering. Jan 1990. 35p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. Order Number DE90009206. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Fast ion conductors (FIC) are of growing interest as components of advanced electrochemical energy conversion devices. Amorphous FICs, known to exhibit a number of attractive characteristics, including ease of fabrication and lack of grain boundaries, await extensive commercial application due to their often poor electrochemical stability. Our laboratory has focused, in the past, on glasses in the system Li_2O-LiCl-B_2O_3 as well as Na and K analogs. Lithium chloride was found to markedly enhance the Li ion conductivity but also to degrade the chemical stability of glasses in contact with molten lithium. Based on thermodynamic considerations, CaO additives are expected to improve the durability of such glasses. 48 refs, 18 figs., 1 tab.

26219 (N–90-12658) **Tribological properties of ceramic/Ti3Al-Nb sliding couples for use as candidate seal materials to 700°C.** Dellacorte, C.; Steinetz, B.M.; Brindley, P.K. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1989. 21p. (NASA-TM–102401;E–5048;NAS–1.15:102401;CONF-900419–: 8. international triennial conference on thin films and the 17th international conference on metallurgical coatings, San Diego, CA (USA), 1-6 Apr 1990). Available from NTIS, PC A03/MF A01.

Tribological properties of Ti3Al-Nb intermetallic disks sliding against alumina-boria-silicate fabric were ascertained in air at temperatures from 25 to 700 C. These materials are candidates for sliding seal applications for the National AeroSpace Plane. The tests were done using a pin on disk tribometer. Sliding was unidirectional at 0.27 m/sec under a nominal contact stress of 340 kPa. Gold sputter or ion plating deposited films were used to reduce friction and wear. Rhodium and palladium films were used beneath the gold lubricating films to prevent diffusion of the substrate into the gold at high temperature. The friction and wear of the unlubricated specimens was unacceptable. Friction coefficients were generally greater than 1.0. The ion plated gold films, when used with a rhodium diffusion barrier reduced friction by almost a factor of 2. Wear was also substantially reduced. The sputter deposited films were not adherent unless the substrate was sputter cleaned immediately prior to film deposition. Palladium did not function as a diffusion barrier.

26220 (N–90-14294) **Parametric studies to determine the effect of compliant layers on metal matrix composite system.** Caruso, J.J.; Chamis, C.C.; Brown, H.C. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1990. 13p. (NASA-TM–102465;E–5252;NAS–1.15:102465;CONF-900439–: 35. international symposium and exhibition of the Society of the Advancement of Material and Process Engineering: advanced materials, the challenge for the next decade, Anaheim, CA (USA), 2-5 Apr 19 Available from NTIS, PC A03/MF A01.

Computational simulation studies are conducted to identify compliant layers to reduce matrix stresses which result from the coefficient of thermal expansion mismatch and the large temperature range over which the current metal matrix composites will be used. The present study includes variations of compliant layers and their properties to determine their influence on unidirectional composite and constituent response. Two simulation methods are used for these studies. The first approach is based on a three-dimensional linear finite element analysis of a 9 fiber unidirectional composite system. The second approach is a micromechanics based nonlinear computer code developed to determine the behavior of metal matrix composite system for thermal and mechanical loads. The results show that an effective compliant layer for the SCS 6 (SiC)/Ti-24Al-11Nb (Ti3Al + Nb) and SCS 6 (SiC)/Ti-15V-3Cr-3Sn-3Al (Ti-15-3) composite systems should have modulus 15 percent that of the matrix and a coefficient of thermal expansion of the compliant layer roughly equal to that of the composite system without the CL. The matrix stress in the longitudinal and the transverse tangent (loop) direction are tensile for the Ti3Al + Nb and Ti-15-3 composite systems upon cool down from fabrication. The fiber longitudinal stress is compressive from fabrication cool down. Addition of a recommended compliant layer will result in a reduction in the composite modulus.

26221 (ORNL/ATD–25) **Low-temperature phosphor thermometry: Calibration of europium-doped lanthanum oxysulfide between room temperature and −194°C.** Simmons, C.M.; Beshears, D.L.; Cates, M.R. Oak Ridge National Lab., TN (USA). Applied Technology Div. Feb 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007917. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Remote-temperature measurements can be accomplished by inducing fluorescence in doped phosphors and measuring emission lifetimes. Some phosphors have been calibrated for high temperature measurement from room temperature to about 1200°C and are proving useful where remote sensing is require. Attention is now turned to remote thermal sensing at low-temperature ranges. Because is has strong emission spectra at low temperatures, as well as relatively high temperatures, lanthanum oxysulfide

(La_2O_2S:Eu) is now being calibrated at low temperatures. The temperature range of concern in this paper is from about −194°C to room temperature. 3 refs., 7 figs.

26222 (SAND–87-8215B) **The Chemkin Thermodynamic Data Base.** Kee, R.J.; Rupley, F.M.; Miller, J.A. Sandia National Labs., Livermore, CA (USA). Mar 1990. 155p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DR00789. Order Number DE90007953. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The Chemkin general-purpose chemical kinetics package uses a data base that contains polynomial fits to specific heats, standard state enthalpies, and standard state entropies. The fourteen coefficient fits are in the same form as used in the NASA Complex Chemical Equilibrium Program (Gordon and McBride, 1971). This report represents a compilation of the data that is currently in use at Sandia National Laboratories. 16 refs.

26223 (SAND–89-2565C) **Chemistry of anomalous-dispersion phase-matched second harmonic generation.** Cahill, P.A. (Sandia National Labs., Albuquerque, NM (USA)); Singer, K.D. Sandia National Labs., Albuquerque, NM (USA). [1990]. 24p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900402–5: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990). Order Number DE90009281. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The anomalous dispersion associated with a strong absorption in some carefully chosen asymmetric dyes permits efficient phase-matched SHG at a given frequency and concentration. One of these dyes was recently used to demonstrate the validity of the two-state model for β, and leads to a method of enhancing second harmonic coefficients in poled polymer systems by 10^1 to 10^4. The factor that primarily limits the utility of this process is the residual absorbance in a nearly transfer band. One figure of merit for comparing dyes for this application is the ratio between this minimum absorbance and ε_{max}; for many dyes this ratio is only 10^{-1} to 10^{-2}. Synthesis of new dyes has led to $\varepsilon_{min}/\varepsilon_{max}$ ratios of 10^{-3} to 10^{-4}. 13 refs., 8 figs.

26224 (UCRL–100125) **A survey of the dynamic characteristics of toolholders for diamond turning.** Franse, J. (Philips Research Labs., Eindhoven (Netherlands)); Roblee, J. Lawrence Livermore National Lab., CA (USA). Jul 1989. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8909314–1: 5. international precision engineering seminar, Monterey, CA (USA), 18-22 Sep 1989). Order Number DE90009187. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Four different sized toolholders used in diamond turning at LLNL were tested for their dynamic compliance at the tool tip. Two of the toolholders were entirely of LLNL design, one was an LLNL modified, special order toolholder, and one was a general purpose, commonly available toolholder. The toolholder is a critical component of a diamond turning machine because it is the final element in the structural loop between tool and workpiece. Unfortunately, its compliance is often overlooked when designing a machine tool because of their small size and high strength. However, high strength does not equate to high stiffness, and the requirements of convenient tool height adjustment and angular orientation often dominate stiffness considerations. Finally, the tool bit and the method of clamping the shank can also be a significant source of compliance. The test techniques and the equipment used for these measurements are similar to those used for testing the Precision Engineering Research Lathe. Here, each of the toolholders was rigidly attached to a massive granite table and a dummy tool bit, with the same dimensions as a diamond tool, was mounted in the holder the same way a diamond tool would be. To this dummy tool bit, an accelerometer and an electrodynamic shaker could be attached. The dynamic force applied by the shaker was measured by a quartz-crystal type, force transducer mounted in series with the shaker. From measured accelerations and forces, the dynamic compliances (amplitude and phase) of the toolholders were determined up to a frequency of 1000 Hz. Alternatively, we used a dummy tool bit with flat reference surfaces and a capacitance gage to measure the dynamic tool motion. 6 refs., 7 figs., 1 tab.

26225 (UCRL-ID–103307) **Recommendations for diamond turning machine maintenance and quality assurance at Cleveland Crystal.** Taylor, J.S.; Clouser, R.W.; Blaedel, K.L.; Marchi, F.T. Lawrence Livermore National Lab., CA (USA). Mar 1990. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90007931. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Laser damage patterns have been observed on NOVA debris shields that resemble the diamond turning patterns on KDP crystals. These patterns are circular arcs whose radius corresponds to the flycutting operation on the Pneumo diamond turning machine; the spacing between the arcs of damage is of the order of 1 mm. A trip was made to Cleveland Crystal (CC) for the purpose of identifying and possibly correcting machine tool problems associated with the damage pattern. Tests were run where the relative motion between the spindle and the chuck was monitored along with environmental variables such as shower oil and room air temperature. A 2 μinch p-v spindle-to-chuck motion correlated with an 18 second cycle in the shower oil temperature; this cycle time corresponds to about a 1.1 mm spatial wavelength during machining. The replacement of a temperature sensor in the oil temperature control system dramatically reduced the spindle-to-chuck motion at this period. Beam modulation tests performed on KDP crystals prepared after the trip indicate that the waviness problem continues to persist. The ultimate cause of the problem may be associated with variables not measured during the trip, e.g. spindle or carriage motion errors. During the course of testing at Cleveland Crystal, several deficiencies in the machine tool set-up were observed [some identified by CC]. One of the principal deficiencies is the lack of monitoring equipment and background information on the machine tool and the support systems. For example, minimal information [outside of our past experiences on similar machines] was available on the temperature control system for the shower oil.

26226 (UCRL-JC–103223) **Magnetron sputtered boron films and Ti/B multilayer structures.** Makowiecki, D.M.; Jankowski, A.F.; McKernan, M.A.; Foreman, R.J. Lawrence Livermore National Lab., CA (USA). Mar 1990. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9005148–1: Integrated contractors meeting and SUBWOG 12A meeting on coatings, Livermore, CA (USA), 8-9 May 1990). Order Number DE90009190. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Boron and Ti/B films have been magnetron sputter deposited and characterized using x-ray diffraction, Auger-depth profiling, and electron microscopy. The amorphous boron films contain no morphological growth features, unlike those characteristically found in thin films prepared by various PVD processed was a major factor in controlling the deposition process. Consequently, the RF sputter deposited boron proves feasible for ultra-thin band pass filters as well as the low Z element in high Z/low Z mirrors which enhance reflectivity from grazing to normal incidence, 10 refs., 8 figs., 2 tabs.

26227 Characterizaation of imperfections in thin-film multilayer devices. Saxena, A. M. (Brookhaven National Lab., Upton, NY (USA). Biology Dept.). pp. 210 of Thin-film neutron optical devices: Mirrors, supermirrors, multilayer monochromators, polarizers, and beam guides. Majkrzak, C. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract AC02-76CH00016. Grant-PCM84-000868. (CONF-8808212–: Thin-film neutron optical devices: mirrors, supermirrors, multilayer monochromators, polarizers, and beam guides, San Diego, CA (USA), 16-17 Aug 1988).

The fabrication of high reflectivity multilayer monochromators usually involves depositing a greater number of bilayers that the calculated number of perfect multilayers. This deviation from ideal behavior occurs due to the presence of imperfections in layers. These imperfections are strongly dependent on the deposition process employed and the parameters during deposition. The author presents a characterization of the types of imperfections present. The imperfections should be taken into consideration for determining the sequence of d-spacing for making a supermirror.

26228 EXAFS studies of cobalt silicide formation produced by high dose ion implantation. Tan, Z. (Univ. of Connecticut, Dept. of Physics and Institute of Materials Science, Storrs, CT

(US)); Budnick, J.I.; Namavar, F.; Hayden, H.; Fasihuddin, A.F.; Sanchez, F.; Tourillon, G. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1987). (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

The early stages of cobalt silicide formation in high dose cobalt implanted Si(100) are studied by extended X-ray absorption fine structure (EXAFS), X-ray diffraction (XRD) and Rutherford backscattering spectroscopy (RBS). Locally ordered silicide that is not detectable in XRD has been observed with EXAFS in the as-implanted samples. Long-range ordered phases are observed in the 3×10^{17}Co/cm^2 samples. After thermal annealing at 700-750°C, single phase $CoSi_2$with (400) orientation is formed in all implants.

26229 Synchrotron microtomography of composites. Stock, S.R. (Mechanical Properties Research Lab. and School of Materials Engineering, Georgia Institute of Technology, Atlanta, GA (US)); Breunig, T.M.; Antolovich, S.; Kinney, J.H.; Johnson, Q.C.; Bonse, U.; Nichols, M.C. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

X-ray computed tomography (CT) uses absorption profiles from many different viewing directions to reconstruct the two-dimensional distribution of x-ray absorptivity within a slice of the sample. The tunability, high brightness and parallelism of synchrotron radiation are critical to high resolution (0.001mm), high contrast (1%) CT or microtomography. The authors describe continuous fiber SiC/Al composites deformed under three-point bending, and the resulting damage and fiber arrangement revealed with synchrotron microtomography. Several hundred slices were recorded using 25 keV radiation and a phosphor screen/charge coupled device (CCD) detector. Reconstruction was with the filtered back projection method. Low density regions were observed in the matrix in regions of highest stress where cracking is expected.

26230 Structural studies of Nickel films and their interface with sapphire substrates. Sparks, C.J.; Hasaka, M.; Easton, D.S.; Baik, S.; Habenschuss, T.; Ice, G.E. pp. 811 of Interfaces, superlattices, and thin films. Dow, J.D.; Schuller, I.K. Materials Research Society, Pittsburgh, PA (USA) (1987). (CONF-8612131–: Materials Research Society symposium on interfaces, superlattices and thin films, Boston, MA (USA), 1-6 Dec 1986).

The authors discuss the perfection of epitaxial nickel films grown on the basal plane of heated sapphire (A_20_3) single crystals studied with X-ray diffraction techniques. Nickel films approximately 700 Å thick formed by vapor deposition increased in perfection as the temperature of the sapphire approached 1400°C. Although the nickel atom distances are 10.3% smaller than those of the closed-packed direction in sapphire, the strain was accommodated at the interface rather than being distributed through the thickness of the nickel film. Diffuse rods of X-ray scattering which are associated with diffraction from the interface gave information about the nature of the roughness at the interface.

26231 The preparation of SiGe thermoelectric materials by mechanical alloying. Cook, B.A. (Ames Lab., U.S. Department of Energy, Iowa State Univ. Ames, IA (US)); Beaudry, B.J.; Harringa, J.L.; Barnett, W.J. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). DOE Contract W-7405-ENG-82. (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899292.

The authors describe the preparation of SiGe thermoelectric materials by mechanical alloying. This technique has the advantage of producing homogeneous, fine grained alloys at room temperature. Optical metallography and electron microscopy have indicated that the average particle/grain size of the alloys produced is considerably less than one micron. X-ray diffraction measurements have verified alloy formation in these materials. Electrical resistivity, Seebeck coefficient, and thermal diffusivity have been measured on several hot pressed compacts and the results are compared with conventional state-of-the-art SiGe alloys. Of four preliminary samples studied, a maximum figure-of-merit of 0.88×10^{-3} C^{-1} at 900°C was found.

26232 Multiple doping of silicon-germanium alloys for thermoelectric applications. Fleurial, J.P. (California Inst. of Tech., Pasadena, CA (USA). Guggenheim Jet Propulsion Center); Vining, C.B.; Borshchevky, A. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. . IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899503.

Improved silicon-germanium alloys currently under development are expected to result in substantial mass and cost savings for space nuclear power systems due to improved thermoelectric figure of merit values. Recent experimental and theoretical efforts on n-type gallium phosphide doped silicon-germanium (SiGe/GaP) indicate significant gains in thermoelectric figure of merit values can be achieved by increasing the carrier concentration. Results are reported on an experiment to test this hypothesis in both n- and p-type zone leveled silicon-germanium alloys which have been simultaneously saturated with both phosphorus and arsenic.

26233 Zimbabweite, $Na(Pb,Na,K)_2As_4(Ta,Nb,Ti)_4O_{18}$, an arsenite-tantalate with a novel corner-linked octahedral sheet. Duesler, E.N. (Univ. of New Mexico, Albuquerque (USA)); Chakoumakos, B.C.; Foord, E.E. *American Mineralogist (USA)*, 73(9-10): 1186-1190 (Sep-Oct 1988). DOE Contract FG04-84ER45099.

Zimbabweite, $Na(PbNa_{0.5}K_{0.5})As_4(Ta_3Nb_{0.5}Ti_{0.5})O_{18}$, from Karoi District, Zimbabwe, is orthorhombic, a = 12.245(2), b = 15.287(4), c= 8.684(1) Å, V = 1625.7(5) Å, space group Cemb, Z = 4. The crystal structure has been determined by direct methods and refined by the method of least-squares to an R factor of 0.070, based on 1335 independent reflections measured on an automated single-crystal X-ray diffractometer. The crystal structure, structural formula $M(3)M(2)_2As_4M(1)_4O_{18}$, has a novel bronze-type, corrugated, corner-linked $M(1)_4O_{18}$ octahedral sheet made up of four- and eight-membered octahedral rings parallel to (100). Within the octahedral sheet, a large distorted seven-coordinated site, M(3), is occupied by Na. The octahedral sheets are cross-linked by trigonal-pyramidal arsenite groups and trigonal prisms around M(2), which is occupied by $(PbNa_{0.5}K_{0.5})$. The perfect (010) cleavage breaks the least number of bonds perpendicular to the octahedral sheet, leaving intact, densely packed (010) slabs with cross-linked four-membered octahedral rings. Zimbabweite represents a new structure type.

26234 Traps in molecular-beam epitaxial $In_{0.53}(Ga_xAl_{1-x})_{0.47}As/InP$. Biswas, D. (Center for High-Frequency Microelectronics and Solid State Electronics Laboratory, Department of Electrical Engineering and Computer Science, The University of Michigan, Ann Arbor, Michigan 48109-2122 (USA)); Chin, A.; Pamulapati, J.; Bhattacha *Journal of Applied Physics (USA)*, 67(5): 2450-2453 (1 Mar 1990).

Deep-level transient spectroscopy measurements have been made on molecular-beam epitaxial $In_{0.53}(Ga_xAl_{1-x})_{0.47}As$ lattice matched to InP. Several electron and hole traps, with activation energies ranging from 0.14 to 0.79 eV, have been identified and characterized. In particular, systems of electron traps ($0.30 \leq \Delta E_T \leq 0.79$ eV) and hole traps ($0.14 \leq \Delta E_T \leq 0.31$ eV) with monotonically changing activation energies have been identified in these alloys. We believe these traps are dominant in this alloy system.

26235 $[LI(Me_2NCH_2CH_2NMe_2)_2]$ $[Li_2(Me_2CH_2\ NMe_2)_2$ - $(\eta\text{-}\nu^5, \nu^5\text{-}MeC_5H_4)]$ $[(\eta^5\text{-}MeC_5H_4)_6\ U_2(\mu\text{-}Me))]_2$: A compound with symmetrically bridging MeC_5H_4 and Me groups. Stults, S.D. (Lawrence Berkeley Lab., CA (USA)); Andersen, R.A.; Zalkin, A. *Journal of the American Chemical Society (USA)*, 111(12): 4507-4508 (7 Jun 1989). DOE Contract AC03-76SF00098.

Organometallic compounds of the alkali metals which contain symmetrical bridging cyclopentadienyl groups, i.e., those in which two metal centers are located at equal distance on either side

of and on the pseudo C_5-axis of the cyclopentadienyl group, are rare; the only example is the linear zigzag polymeric structure of [$Na(Me_2NCH_2CH_2NMe_2)Cp$]. The authors describe the synthesis and x-ray crystal structure of [$Li\text{-}(Me_2NCH_2CH_2NMe_2)_2$]·[$Li(Me_2NCH_2CH_2NMe_2)]_2[\mu\text{-}MeC_5H_4]$·[$(MeC_5H_4)_3U]_2[\mu\text{-}Me$], a compound that contains a MeC_5H_4 group sandwiched between two $Li(Me_2NCH_2CH_2NMe_2)$ fragments and a methyl group that is symmetrically bridging between two $(MeC_5H_4)_3U$ groups.

26236 Metalloradical activation of CO: Formation and carbonyl coupling of a bent 17-electron M-CO unit. Sherry, A.E. (Univ. of Pennsylvania, Philadelphia (USA)); Wayland, B.B. *Journal of the American Chemical Society (USA),* 111(13): 5010-5012 (21 Jun 1989).

Carbonyl carbon centered radical reactivity in organo-transition-metal complexes has been previously observed only for transient 19-electron species. Abstraction of hydrogen from metal hydrides by $[Fe(CO)_5]^-$ to form an intermediate 18-electron formyl complex, $[Fe(CO)_4CHO]^-$, is a prominent example of this type of reactivity. Studies of rhodium porphyrins with CO that produce metalloformyl, dimetal ketones, and dimetal α-diketons have suggested that a 17-electron metalloorganic radical, (por)Rh-CO, may function as an intermediate, but this type of species has eluded direct observation. This article reports on the reversible reaction of tetramesitylporphyrinrhodium(II), (TMP)Rh·, with CO to form (TMP)Rh-CO, 2 which dimerizes by C-C bond formation. EPR and reactivity studies of 2 indicate the presence of a bent CO fragment with a partially rehybridized CO unit that facilitates one-electron reactions at the carbonyl carbon center.

26237 Adsorption of CO and CO_2 on clean and cesium-covered Cu(110). Rodriguez, J.A. (Indiana Univ., Bloomington (USA)); Clendening, W.D.; Campbell, C.T. *Journal of Physical Chemistry (USA),* 93(13): 5238-5248 (29 Jun 1989).

The interactions of Cs with Cu(110) and the coadsorption of CO and CO_2 with Cs on Cu(110) have been studied with X-ray photoelectron spectroscopy, Auger electron spectroscopy, work function measurements, and thermal desorption mass spectroscopy (TDS). Cesium adsorbs in relatively cationic form at low coverages, depolarizing to relatively neutral, bulklike Cs by one close-packed monolayer ($\theta_{Cs}^* = 1.0$). At low θ_{Cs}^*, indirect interactions stabilize CO_a by $\sim$ 15% relative to its desorption temperature ($\sim$ 220 K) from clean Cu(110). For $\theta_{Cs}^* > 0.5$, a CO_a-Cs_a complex appears, which decomposes at 400-500 K with simultaneous Cs and CO evolution in TDS. For a fixed CO dose, the concentration of this complex increases with θ_{Cs}^*, reaches a maximum at $\theta_{Cs}^* \cong 1.1$, and decreases rapidly to zero at $\theta_{Cs}^* = 2.0$. No CO will adsorb on Cs multilayers at 110 K. No CO_2 adsorption could be detected on clean Cu(11) at 110 K. A cesium/carbonate surface complex is formed already from the lowest Cs coverages and all higher Cs coverages below 180 K via $2CO_{2g} + Cs_a \rightarrow CO_a = Cs \times CO_{3,a}$ (perhaps through an O_a or oxalate intermediate). Weakly adsorbed CO_2 is also seen when Cs_a is present, desorbing at $\sim$ 130 K. The $Cs \times CO_{3,a}$ complex decomposes in a complex TDS spectrum at 500-700 K via $Cs \times CO_{3,a} \rightarrow Cs_a + CO_{2,g} + O_a$. Cs_a then desorbs at high coverages simultaneous to CO_2 evolution. The implications of these results to Cs promotion of catalytic water-gas shift and methanol synthesis over Cu are discussed.

26238 Scanning tunnelling microscopy of platinum films on mica. Evolution of topography and crystallinity during film growth. Scott, E.R. (Univ. of Minnesota, Minneapolis (USA)); White, H.S.; McClure, D.J. *Journal of Physical Chemistry (USA),* 93(13): 5249-5253 (29 Jun 1989).

Scanning tunneling microscopy (STM) was used to characterize the topography and crystallinity of Pt films deposited on mica by rf sputtering. Three stages of film growth were identified by STM for films of thicknesses, d, between 20 and 1,500 Å. Images of ultrathin Pt films, $d < 50$ Å, show a rippled topography with no resolvable features associated with ordered crystalline growth. At intermediate coverages, $60 < d < 200$ Å, 50-150-Å-diameter crystalline grains are resolved by STM. The shape and size of these grains are nearly identical with that observed by transmission electron microscopy. Large, flat grains (diameter $\approx$ 1,000 Å) with a nearly atomically smooth topography are observed for films of thickness { >=} 500 Å. STM images of Pt films immersed under water and in mineral oil and images of mobile surface contaminants are also reported.

26239 Effusion studies of the decomposition of $CuSO_4$ and CuO x $CuSO_4$. Brittain, R.D. (SRI International, Menlo Park, CA (USA)); Lau, K.H.; Hildenbrand, D.L. *Journal of Physical Chemistry (USA),* 93(13): 5316-5319 (29 Jun 1989).

Both the torsion-effusion technique and high-temperature mass spectrometry were used to study the thermal decomposition of the copper sulfate and oxysulfate phases $CuSO_4$ and CuO x $CuSO_4$ at about 700-780 K. The decomposition processes are retarded kinetically; SO_3 is the primary gaseous product, rather than the dominant equilibrium products SO_2 and O_2. Significant orifice size effects were observed for both salts. Although the extrapolated SO_3 pressure at zero orifice area for CuO x $CuSO_4$ agrees closely with that calculated from accurate calorimetric data for the process CuO x $CuSO_4(s) = 2CuO(s) + SO_3(g)$, the corresponding SO_3 pressure for $CuSO_4$ is more than a factor of 3 higher than that calculated from presumably reliable thermodynamic data. Pt powder, found to be an effective catalyst for the decomposition of magnesium and zinc sulfates at higher temperatures, showed no detectable effect on the decomposition pressures of the copper sulfates, although the effusing gas was converted to the $SO_2 + O_2$ equilibrium mixture. Results are compared with effusion studies on other sulfate systems.

26240 Variable-temperature magic-angle-spinning technique for studies of mobile species in solid-state NMR. Tokuhiro, Tadashi (Massachusetts Institute of Technology, Cambridge (USA)); Mattingly, M.; Iton, L.E.; Ahn, M.K. *Journal of Physical Chemistry (USA),* 93(14): 5584-5587 (13 Jul 1989). DOE Contract W-31109-ENG-38.

The utility of variable-temperature (VT) magic-angle-spinning (MAS) Fourier transform nuclear magnetic resonance (FT-NMR) spectroscopy is demonstrated for the study of mobile species in solids, especially when quadrupolar nuclei are being observed. A new VT-MAS probe is described for use in the temperature range 150-400 K, using spectrometers with high-field superconducting magnets. It has been utilized in studies of the bonding and dynamics of alkali-metal cations in hydrated zeolites at an applied field of 7.05 T. Results are presented for the cases of Cs/Na-A and Cs/Li-A zeolites, in which the Cs^+ ions exchange rapidly, at 293 K, between six-ring and eight-ring sites in the large cage, so that on the time scale of the NMR measurements the ions are indistinguishable and a single ^{133}Cs resonance is observed. Below 250 K, two well-resolved signals are observed in the Cs/Na-A zeolite, 107 ppm apart. These are easily assigned to the Cs^+ ions in the two sites, the large difference in chemical shifts being attributed to the stronger bonding of Cs^+ ions at the six-ring sites. Three sites are distinguished in the Cs/Li-A zeolite, the third site being assigned to a position near a four-ring in the large cage.

26241 The structure of self-assembled monolayers of alkylsiloxanes on silicon: A comparison of results from ellipsometry and low-angle x-ray reflectivity. Wasserman, S.R. (Harvard Univ., Cambridge, MA (USA)); Whitesides, G.M.; Tidswell, I.M.; Ocko, B.M.; Pershan, P.S.; Axe, J.D. *Journal of the American Chemical Society (USA),* 111(15): 5852-5861 (19 Jul 1989). DOE Contract AC02-76CH00016.

The thicknesses of C10-C18 alkylsiloxane monolayers on silicon-silicon dioxide substrates have been measured with ellipsometry and low-angle X-ray reflection. Although, for any given sample, thicknesses measured by the two methods agree to within experimental error, ellipsometric measurements are systematically larger by approximately 2 Å. This difference may result from variations in the sensitivity of the two techniques to the structure of the interface between silicon dioxide and the alkylsiloxane monolayer. The x-ray reflectivity measurements provide evidence that these organic monolayers do not build up as island structures and demonstrate that the approximate area projected by each alkyl group in the plane of the monolayer is $\sim 21 \pm 3$ Å^2. Preliminary studies indicate that this technique can be used to follow the changes in the structure of a monolayer which result from chemical transformations. The influence of damage that is induced by x-ray radiation on these measurements is discussed.

26242 Growth mechanisms of silver halide clusters from the molecule to the colloidal particle. Hayes, D. (Argonne National Lab., IL (USA)); Schmidt, K.H.; Meisel, D. *Journal of Physical Chemistry (USA),* 93(16): 6100-6109 (10 Aug 1989). DOE Contract W-31109-ENG-38.

Studies of growing silver halide clusters, from the molecular level to colloidal-size particles, have been undertaken and correlations between particle size and physical properties have been investigated. The production of halide ions by dissociative electron attachment following pulse radiolysis of methylene halide solutions was utilized to instantaneously produce homogeneous, supersaturated solutions of halide and silver ions. The growth of silver halide particles in these solutions has been examined by conductance, absorption spectroscopy, and light scattering measurements. Conductivity measurements show that the initial reaction between the ions occurs at a diffusion-controlled rate and allow determination of the stability constants of molecular silver halide species. In solutions containing excess silver ions, particle growth of silver iodide and silver bromide occurs via a diffusion-controlled aggregation mechanism during the first seconds. The growth rate is reduced significantly, due to electrostatic repulsion between particles, when the concentration of halide ions is almost equal to or greater than the stoichiometric concentration of silver ions. The absorbance of silver iodide suspensions produced in this manner has also been measured. The initial absorbance, due to AgI molecules, occurs at wavelengths of 280 nm and below. The lowest energy exciton band appears $\sim$ 50 μs after initiation of the reaction. This band initially peaks at around 320 nm and shifts toward 425 nm (the wavelength of exciton absorption in bulk silver iodide). The surface potential at the interface evolves at about the same rate as the bulk properties of the material. For the mostly dissociated AgCl molecules growth by addition of ions to a small number of particles of critical size was observed.

26243 Stabilization of metal ensembles at room temperature: Palladium clusters in zeolites. Moller, K. (Univ. of New Mexico, Albuquerque (USA)); Bein, T.; Koningsberger, D.C. *Journal of Physical Chemistry (USA),* 93(16): 6116-6120 (10 Aug 1989). DOE Contract AS05-80ER10742.

Palladium clusters of low nuclearity have been prepared in the cavities of X zeolites via ion exchange with $Pd(NH_3)_4Cl_2$, oxidative dehydration, and subsequent reduction of the dry Pd(II) zeolites with hydrogen at 295 and 425 K. Detailed EXAFS analysis of Pd K-edge data shows that the average first-shell Pd-Pd coordination number of the reduced system is only about N = 1.5 at a distance of 2.78 Å. A long, relatively disordered coordination of the reduced Pd to framework oxygen and silicon indicates the stabilizing, templating function of the zeolite matrix. Geometric models based upon the EXAFS results show that intrazeolite Pd_2, Pd_3, and Pd_4 clusters are formed by partial occupation of SI′ and SII′ positions of the sodalites subunits of the zeolite. This study presents evidence for the formation of molecular metal ensembles stabilized in as open-framework matrix to at least 425 K.

26244 Voltammetry of semiconductor electrodes. 2. Cyclic voltammetry of freely diffusing redox species and rotating semiconductor disk voltammetry. Santangelo, P.G. (California Institute of Technology, Pasadena (USA)); Miskelly, G.M.; Lewis, N.S. *Journal of Physical Chemistry (USA),* 93(16): 6128-6136 (10 Aug 1989).

A model electrode circuit has been utilized to describe the cyclic voltammetric response of a semiconductor photoelectrode in contact with a freely diffusing reversible redox system. This equivalent circuit formalism also has been used to generate a set of working curves for the steady-state voltammetric behavior of a reversible redox system at a rotating semiconductor disk electrode. The model electrode circuit consisted of an ideal photodiode in series with a metal electrode. The current-voltage solutions have been obtained under varying conditions of illumination, scan rate, or rotation velocity, and the results are presented in a working curve format.

26245 π-bonded complex between aluminum and ethylene. Xie, Yaoming (Univ. of Georgia, Athens (USA)); Yates, B.F.; Yamaguchi, Yukio; Schaefer, H.F. III. *Journal of the American Chemical Society (USA),* 111(16): 6163-6167 (2 Aug 1989). DOE Contract FG09-87ER13811.

There are several possible isomeric complexes between atomic Al and C_2H_4. Only the π-bonded complex appears to have been observed experimentally to date. Ab initio quantum mechanical methods have been applied to this problem and confirm theoretically for the first time that the π-bonded structure is strongly bound (D_0 > 11 kcal/mol). The highest level at which a full vibrational analysis has been carried out is configuration interaction including all single and double excitations (CISD) employing a double-ζ plus polarization (DZ + P) basis set. A second minimum, corresponding to Al-methylcarbene, lies less than 5 kcal/mol above the π-bonded global minimum. The σ-bonded classical ethyl radical structure is predicted to collapse to the π-bonded structure when the effects of electron correlation are considered explicitly.

26246 Time-resolve luminescence of electron-hole pairs in CdS_xSe_{1-x} graded semiconductors. Hane, J.K. (Univ. of California, Berkeley (USA)); Prisant, M.G.; Harris, C.B.; Meyer, G.J.; Leung, L.K.; Ellis, A.B. *Journal of Physical Chemistry (USA),* 93(24): 7975-7977 (30 Nov 1989). DOE Contract AC03-76SF00098.

Time-resolved photoluminescence (PL) from graded CdS_xSe_{1-x} samples that exhibit spatially resolved PL has been used to study the dynamics of nonequilibrium distributions of electron-hole pairs in air at 295 K. Samples have been studied with the band gap increasing both toward the surface (CdSe/S) and toward the bulk (CdS/Se). Decay times (1/e) in PL spectra for CdS/Se and CdSe/S samples, measured between $\approx$ 500 and 740 nm, occur over roughly 100-400 ps and are strongly dependent on detection wavelength, reflecting carrier dynamics. The decay traces show a nonmonotonic dependence on detection wavelength.

26247 Detection of EPR spectra in S = 2 states of trivalent manganese complexes. Dexheimer, S.L. (Lawrence Berkeley Lab., CA (USA)); Gohdes, J.W.; Chan, M.K.; Hagen, K.S.; Armstrong, W.H.; Klein, M.P. *Journal of the American Chemical Society (USA),* 111(24): 8923-8925 (22 Nov 1989). DOE Contract AC03-76SF00098.

The presence of trivalent manganese is implicated in a number of redox-active metalloenzymes, including the photosynthetic oxygen-evolving complex, superoxide dismutase, pseudocatalase, and ribonucleotide reductase. Considerable effort has been focused on the synthesis and characterization of inorganic complexes as structural models for these biological metal centers. In this communication data is presented of X-band EPR spectra of S = 2 spin states of 3 trivalent manganese complexes, including the mononuclear manganese (III) tris(acetylacetonate) and tris-(picolinate) coordination complexes and the weakly antiferromagnetically exchange coupled binuclear complex $Mn_2^{III,III}O(O_2CCH_3)_2(HB(pz)_3)_2$ ($HB(pz)_3$ = hydrotris(1-pyrazolyl)borate).

26248 Long-range energy transfer in a soluble polymer by an energy-transfer cascade. Strouse, G.F. (Univ. of North Carolina, Chapel Hill (USA)); Worl, L.A.; Younathan, J.M.; Meyer, T.J. *Journal of the American Chemical Society (USA),* 111(25): 9101-9102 (6 Dec 1989). DOE Contract FG05-86ER13633.

In the study of intramolecular energy or electron transfer, soluble polymers offer the advantage of having multiple sites which can be used to concentrate combinations of chromophores and quenchers within the same molecular framework. We have prepared a functionalized 1:1 copolymer of styrene:m,p (chloromethyl)styrene that contains (1) a polypyridyl complex of Ru^{II} which upon excitation gives a high-energy metal to ligand charge transfer (MLCT) excited state, (2) a polypyridyl complex of Os^{II} which has a lower energy excited state, and (3) an anthryl derivative based on 9-anthracenemethanol which has a triplet state of intermediate energy.

26249 Structural phase transitions in InSb to 66 GPa. Vanderborgh, C.A. (Department of Materials Science and Engineering, Cornell University, Ithaca, New York 14853-1501 (US)); Vohra, Y.K.; Ruoff, A.L. *Physical Review, B: Condensed Matter (USA),* 40(18): 12450-12456 (15 Dec 1989).

Phase transitions in InSb were studied with use of energy-dispersive x-ray diffraction with a synchrotron source to pressures of 66 GPa. InSb transformed from the quasi-fourfold-coordinated zinc-blende structure to a quasi-sixfold-coordinated orthorhombic

structure [InSb(IV)] at 2.5 GPa. Previous workers have claimed that the structure of orthorhombic InSb(IV) is disordered with space group *Pmm*2. From the results of recent theoretical calculations, we suggest that the structure of InSb(IV) is ordered and has space group *Amm*2. Around 6 GPa, InSb transformed to another phase which subsequently continuously transformed to a quasi-eightfold-coordinated hexagonal structure. Upon a further increase in pressure to 28±3 GPa, the sample transformed to an eightfold-coordinated cubic CsCl-type structure (if ordered) or to a bcc structure (if disordered). The structure remains cubic to at least 66 GPa, the highest pressure attained in this study. Both the hexagonal phase and the cubic phase are new phases of InSb. On the basis of theoretical calculations, all of these structures are expected to be ordered. The similarities between this phase-transition sequence in InSb and those of other III-V compounds as well as the isoelectronic element Sn are also discussed.

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Refer also to citation(s) 26118, 26120, 26157, 26158, 26235, 26236, 26237, 26240, 26244, 26246, 26335, 26356, 26358, 26508

26250 Measurement of internuclear distances in polycrystalline solids: Rotationally enhanced transfer of nuclear spin magnetization. Raleigh, D.P. (Massachusetts Institute of Technology, Cambridge (USA)); Creuzet, F.; Das Gupta, S.K.; Levitt, M.H.; Griffin, R.G. *Journal of the American Chemical Society (USA)*, 111(12): 4502-4503 (7 Jun 1989).

A magic angle spinning (MAS) NMR technique for measurement of the distance between two homonuclear sites separated by as much as 0.5 nm is demonstrated. This is achieved by proton decoupling during the magnetization exchange process, greatly attenuating the influence of abundant nuclear spins, selective isotopic labeling of both sites of interest, so that the system may be approximated as a set of magnetically dilute coupled spin pairs, and MAS with matching of the rotational resonance condition. Tyrosine ethyl ester (TEE), carbon 13 labeled at both the -CH_2- of the ester moiety and at the 4′-OH aromatic carbon is used as a demonstration of the technique. Calculated data is compared to experimental data.

26251 Rotational barriers: 4. Dimethoxymethane. The anomeric effect revisited. Wiberg, K.B. (Yale Univ., New Haven, CT (USA)); Murcko, M.A. *Journal of the American Chemical Society (USA)*, 111(13): 4821-4828 (21 Jun 1989).

The conformational energy map for the rotamers of dimethoxymethane has been calculated using both the 3-21G and 6-31G* basis sets with complete geometry optimization in each case. Higher level calculations including electron correlation also have been performed on selected rotamers. At larger torsional angles, the map has approximate 4-fold symmetry, and this symmetry may be used to quantify the difference in the interactions in the (+sc, −sc) and (+sc, +sc) regions. Large changes in bond angles were found, and the dipole moment also changed considerably on C-O bond rotation. Calculations on equatorial and axial 2-methoxytetrahydropyran show that the axial form is favored by 1.33 kcal/mol, in fair agreement with experiment. Calculations also were carried out on the two lowest energy forms of 1,1-dimethoxyethane and on five forms of methyl propyl ether. Consideration of all these data indicates that the anomeric stabilization in dimethoxymethane is much greater than in sterically more congested systems, but the stabilization of 1,1-dimethoxyethane is similar to that of 2-methoxytetrahydropyran and other acetals.

26252 Reaction kinetics of ethylene conversion and hydrogen exchange on Pt by ^2H NMR. Zax, D.B. (Univ. of Illinois, Urbana (USA)); Klug, C.A.; Slichter, C.P.; Sinfelt, J.H. *Journal of Physical Chemistry (USA)*, 93(13): 5009-5012 (29 Jun 1989). DOE Contract AC02-76ER01198.

The authors report the use of deuterium NMR to study two types of reactions involving ethylene adsorbed on small supported Pt metal particles typical of industrial catalysts. They utilized annealing experiments in which the reaction temperature was increased in steps, but all NMR measurements were made at 77 K. The first reaction is the structural rearrangement of ethylene adsorbed at low temperatures (200 K) to the stable room-temperature species (ethylidyne). The second reaction is the exchange between hydrogen atoms in ethylidyne and deuterium atoms adsorbed on the surface at low temperatures (77 K). From their observations they were able to determine the activation energies and preexponentials for these processes.

26253 A shock tube and modeling study of the $CH_3 + CH_2O$ reaction at high temperatures. Choudhury, T.K. (Catholic Univ. of America, Washington, DC (USA)); Sanders, W.A.; Lin, M.C. *Journal of Physical Chemistry (USA)*, 93(13): 5143-5147 (29 Jun 1989). DOE Contract FG05-85ER13373.

The reaction $CH_3 + CH_2O \rightarrow CH_4 + CHO$ has been studied in a shock tube in the temperature range 1,170-1,630 K, and its rate constant has been determined by kinetic modeling of the observed CO formation: $k_1 = 10^{15.0\pm0.4} \exp(-11{,}600 \pm 1{,}260/T)$. The results confirm earlier observations that the Arrhenius plot curves upward rather sharply at temperatures above 1,000 K, although the effect appears less dramatic than reported previously. This nonlinearity cannot be rationalized by a standard transition-state model. However, the inclusion of a correction for quantum mechanical tunneling leads to an acceptable fit of the observed data over the entire experimental range (300-1,700 K). A nonlinear least-squares fit to the calculated values covering 300-2,000 K gives rise to $k_1 = 10^{-12.05}T^{7.4} \exp(483/T)$ $cm^3/mol \times s$.

26254 A reduced dimensionality L^2 simulation of the photodetachment spectra of $ClHCl^-$ and IHI^-. Bowman, J.M. (Emory Univ., Atlanta, GA (USA)); Gazdy, B. *Journal of Physical Chemistry (USA)*, 93(13): 5129-5135 (29 Jun 1989).

The authors present an approximate three-dimensional quantum mechanical simulation of the photodetachment spectra of $ClHCl^-$ and IHI^-. The simulation is based on 2 approximations. The first is an adiabatic treatment of the three-atom bending motion, based on a method that they have used in reduced dimensionality reactive scattering, and the second is an L^2 basis set representation of the Hamiltonian. This representation is primarily directed at the calculation of resonances (and possible bound states in the case of IHI) and is tested for the collinear reactions, where exact quantum results are available. By use of available ab initio and experimental data for the anions, variational wave functions are calculated for them and then used to perform Franck-Condon overlaps with wave functions for the neutral systems. In addition to good overlap with resonance states of the neutral system, they find good overlap with lower energy nonresonance states which have large amplitude at configurations that are close to the equilibrium geometry of the anion. For both Cl + HCl and I + HI semiempirical London-Eyring-Polanyi-Sato (LEPS) surfaces are employed, and their accuracy is assessed based on comparisons with the recent experiments of Neumark and co-workers.

26255 Light-induced electron transfer from a lipid-soluble zinc(II) porphyrin to various electron acceptors in frozen vesicle solutions: Effects of cholesterol on the solubilization sites and radical yields. Lanot, M. (Univ. of Houston, TX (USA)); Kevan, L. *Journal of Physical Chemistry (USA)*, 93(13): 5280-5284 (29 Jun 1989).

The photoionization of zinc tetraphenylporphyrin (ZnTPP) has been studied by electron spin resonance (ESR) at 77 K in rapidly frozen dipalmitoylphosphatidylcholine (DPPC) vesicle solutions, and in the presence of various electron acceptors like tetrachloro- and tetrabromobenzoquinone (TCBQ and TBBQ) and potassium ferricyanide ($K_3Fe(CN)_6$). The photoproduced $ZnTPP^+$ yield was found to increase, and photoinduced anion formation was also detected for added tetrahalobenzoquinones. Incorporation of cholesterol in these systems altered the $ZnTPP^+$ radical yields via 2 main structural changes: (1) ZnTPP-water contact increased due to intercalation of cholesterol between the surfactant headgroups, and (2) TCBQ moved deeper into the vesicle bilayer because of increased bilayer fluidity.

26256 Controlling the pathways in molecular decomposition: The vibrationally mediated photodissociation of water. Vander Wal, R.L. (Univ. of Wisconsin, Madison (USA)); Crim, F.F. *Journal of Physical Chemistry (USA)*, 93(14): 5331-5333 (13 Jul 1989).

Vibrationally mediated photodissociation, in which vibrational overtone excitation prepares a single rovibrational state of water that an ultraviolet photon subsequently dissociates, permits a fully state resolved study of the photodissociation of water. Dissociating water from six different initial rotational states and detecting the OH products by laser-induced fluorescence shows that the distribution of the products among their rotational states depends strongly on the state initially selected in the vibrational overtone excitation step. These measurements also demonstrate the control of the dissociation pathway by selection of different intermediate states. Dissociating water molecules from one vibrational state ($|04>^-$) produces almost no vibrationally excited OH products, but dissociating another state ($|13>^-$) that corresponds to a different nuclear motion produces roughly comparable amounts of OH(v = 1) and OH(v = 0).

26257 Charge transfer and cis-trans photoisomerization. Ebbesen, T.W. (Univ. of Tsukuba, Ibaraki (Japan)); Tokumaru, K.; Sumitani, M.; Yoshihara, K. *Journal of Physical Chemistry (USA)*, 93(14): 5453-5457 (13 Jul 1989).

The photophysical and photochemical properties of cis- and trans-1,2-bis(1-methyl-4-pyridinio)ethylene dication in acetonitrile are examined. These properties are significantly altered by the charge-transfer complexation in the ground state. The free olefins undergo cis-trans photoisomerization with a quantum yield of ca. 0.3. The cis isomer does not fluoresce unlike the trans isomer (ϕ_F = 0.01, $\tau_F = 5 \times 10^{-11}$ s). The fluorescence of the trans isomer is quenched by complexation with iodide ions in the ground state. In addition, static quenching occurs within a 16-Å radius. The constants of the CT complexation with the iodide ion (in the ground state) are 1.6 M^{-1} for cis and 4.6 M^{-1} for trans. Upon excitation in the charge-transfer absorption band, the trans iodide complex gives the trans radical with a quantum yield of 0.06. The cis iodide complex leads not only to the formation of the cis radical isomer with a quantum yield of 0.02 but also to the trans isomer dication (quantum yield 0.05). The latter reaction can be interpreted either as a germinate pair catalyzed event or as isomerization in the excited charge-transfer state from the results of the nanosecond and picosecond laser flash photolysis experiments.

26258 Asymptotic analysis of diffusion-influenced kinetics with a potential. Green, N.J.B. (Univ. of Notre Dame, IN (USA)); Pimblott, S.M. *Journal of Physical Chemistry (USA)*, 93(14): 5462-5467 (13 Jul 1989).

A transformation is introduced and used to formulate a series of approximations for the time-dependent diffusion-controlled geminate reaction probability. Each approximation has the properties of a probability distribution function. The implications of the approximations are analyzed by use of established relationships to give corresponding approximations for the geminate reaction probability with a radiation boundary condition and for the time-dependent rate coefficient with a Boltzmann initial concentration profile. The first-order approximation, which holds when the interparticle forces are weak, is applied to the recombination of ions in an aqueous solution of a strong electrolyte; its accuracy is assessed by comparison with numerical results.

26259 Electron spin-echo modulation of x-doxylstearic acid in nonionic surfactants. Baglioni, P. (Univ. of Udine (Italy)); Bongiovanni, R.; Rivara-Minten, E.; Kevan, L. *Journal of Physical Chemistry (USA)*, 93(14): 5574-5578 (13 Jul 1989).

Electron spin-echo studies have been carried out for a series of x-doxylstearic acid spin probes (x-DSA, x = 5, 7, 10, 12, and 16) in frozen micellar solutions of some poly(ethylene oxide) surfactants, $C_{12}E_6$, $C_{12}E_8$, C_8E_6, and C_8E_8, and in surfactants selectively deuterated along the aliphatic chain or in the poly(ethylene oxide) groups, $(CD)_{12}E_6$, $C_{12}D_6$, C_8D_6, and $(CD)_{12}E_8$, in D_2O and H_2O. Modulation effects due to interactions of nitroxide groups with water deuteriums or deuteriums of deuterated surfactants have been measured as a function of x. The probes are mainly located in the micelle ethylene oxide region. The average probe location in the micelle as a function of x is reported. The results obtained show that no water penetration inside the micelle core and little water penetration into the ethylene oxide region are present and do not support the current view of a fully hydrated ethylene oxide chain. It is found that only one or two ethylene oxide groups are hydrated.

26260 Deconvolution of multivalent cation-exchange isotherms. Triay, I.R. (Los Alamos National Lab., NM (USA)); Rundberg, R.S. *Journal of Physical Chemistry (USA)*, 93(14): 5617-5623 (13 Jul 1989).

A method of deconvolution has been developed to determine the site-specific selectivity coefficients for divalent and trivalent exchange in relatively rigid exchangers. The technique involves the measurement of ion-exchange isotherms and the application of the numerical approach of regularization to effect deconvolution. The method has been designed and extensively tested with computer-generated isotherms. The results of these numerical studies indicate that this approach can successfully recover selectivity coefficient distributions from divalent and trivalent isotherms. If a careful accounting of the exchanging cations is maintained, this method can be applied to systems undergoing ion exchange by different mechanisms.

26261 Picosecond transient absorption spectra of aminosalicylates in confirmation of the triple excitation mechanism. Gormin, D. (Florida State Univ., Tallahassee (USA)). *Journal of Physical Chemistry (USA)*, 93(16): 5979-5980 (10 Aug 1989).

Using picosecond transient absorption studies, it is shown that the twisted intramolecular charge-transfer state (TICT) and the excited intramolecular proton-transfer state (ESIPT or PT) of specific aminosalicylates both contribute to the long-wavelength fluorescence band, F_2, observed as an unresolved band to the red of the normal fluorescence band, F_1. The transient absorption band for 2-hydroxy-4-(dimethylamino)benzoic acid methyl ester (PDASE) is shown to be a composite of the two excited-state absorption modes: S_n''(TICT) ← S_1'' (TICT) and S_n'(PT)← S_1'(PT). This corroborates previous steady-state fluorescence studies of the unresolved F_2 band. The assignments are based on comparison with the excited-state absorption spectra of various substituted aminosalicylates in polar and nonpolar solvents.

26262 Orientational effect on intramolecular triplet excimer formation in 1,n-dinaphthylalkanes. Locke, R.J. (Wayne State Univ., Detroit, MI (USA)); Lim, E.C. *Journal of Physical Chemistry (USA)*, 93(16): 6017-6019 (10 Aug 1989).

The time-resolved emission spectra of a series of di-β-substituted 1,n-dinaphthylalkanes have been investigated in isooctane at room temperature. Phosphorescence from the triplet excimer has been observed for the longer alkyl chain derivatives (n = 3,4) but not from the short-chain species (n = 1,2). Under identical experimental conditions, the excimer phosphorescence from the βderivatives is blue shifted and is much weaker than that of the corresponding α isomers. Furthermore, the decay rates are much greater for the di-β molecules. These results confirm the previously proposed L-shaped structure of the triplet excimers of naphthalene.

26263 Adsorption and reactions of methanethiol on clean and modified Ni(110). Huntley, D.R. (Oak Ridge National Lab., TN (USA)). *Journal of Physical Chemistry (USA)*, 93(16): 6156-6164 (10 Aug 1989). DOE Contract AC05-84OR21400.

The reactions of methanethiol on clean and modified Ni(110) have been studied under ultrahigh-vacuum conditions by temperature-programmed reactions (TPR), including deuterium incorporation studies. Surface bound molecular fragments were identified by X-ray photoelectron spectroscopy (XPS) and high-resolution electron energy loss spectroscopy (HREELS). The TPR data indicate that the major products of the reactions of methanethiol with clean Ni(110) surfaces are methane and hydrogen. Methane desorbs in a reaction-limited peak at 276 K, which does not shift with methanethiol exposure. Hydrogen desorption occurs in several peaks depending on the exposure. The coverage dependence of the methane yield indicates a competition between decomposition and reaction to form methane. At low coverages, decomposition is the major pathway while at higher coverages methane formation dominates. Vibrational spectroscopy (HREELS) indicates the presence of the methyl thiolate intermediate at temperatures less than 200 K. X-ray photoelectron spectroscopy and deuterium incorporation experiments confirm this assignment. A mechanism has been proposed based on hydrogenolysis of the methyl thiolate species and is consistent with all of the data. The appropriate rate equations associated with this mechanism have been solved numerically to predict the TPR data, and qualitative

agreement was achieved. Methanethiol reacts with sulfur- and oxygen-modified Ni(110) surfaces to produce methane, hydrogen, and, in the case of the oxidized surfaces, water. The major effect of the modifier was to enhance the formation of methane relative to decomposition. These observations can be explained by either electronic or structural effects.

26264 Adsorption and surface reactions of H_2S and SO_2 on Cu(100) studied by electron energy loss spectroscopy. Leung, K.T. (Lawrence Berkeley Lab., CA (USA)); Zhang, X.S.; Shirley, D.A. *Journal of Physical Chemistry (USA)*, 93(16): 6164-6170 (10 Aug 1989). DOE Contract AC03-76SF00098.

The adsorption of H_2S and SO_2 on Cu(100) was investigated by use of electron energy loss spectroscopy as a function of coverage, temperature, and scattering angles. In particular, irreversible dissociation of H_2S and the formation of sulfhydryl (SH) species at low and immediate coverage on Cu(100) were observed at low temperature. This was followed by molecular physiadsorption at higher coverage. In the case of SO_2 on Cu(100), decomposition of SO_2 and the formation of SO_3 surface species at room temperature were observed. A surface reaction involving preadsorbed SO_2 on Cu(100) with H_2s is discussed.

26265 Theoretical studies of the hydrogen peroxide potential surface. 1. An ab initio anharmonic force field. Harding, L.B. (Argonne National Lab., IL (USA)). *Journal of Physical Chemistry (USA)*, 93(24): 8004-8013 (30 Nov 1989). DOE Contract W-31109-ENG-38.

Ab initio GVB + 1 + 2 calculations, employing a (4s3p2d1f/3s2p) basis set, have been used to characterize the ground-state potential energy surface of hydrogen peroxide. An anharmonic force field that is quartic in the nontorisonal degrees of freedom and higher order in the torsion is reported. A second-order perturbation theory calculation of the vibrational energy levels using the ab initio force field yields fundamental frequencies that are within 25 cm^{-1} (3%) of experiment. A reaction path analysis of the torsional mode is also presented. The predicted tunneling splitting between the lowest pair of torsional states is 11.214 cm^{-1}. Also calculated are tunneling splittings for excited vibrational states for both H_2O_2 and D_2O_2.

26266 Hg(^{3}P) photosensitized chemistry of ethyl halides in krypton matrix. Cartland, H.E. (Lawrence Berkeley Lab., CA (USA)); Pimentel, G.C. *Journal of Physical Chemistry (USA)*, 93(24): 8021-8025 (30 Nov 1989). DOE Contract AC03-76SF00098.

The reaction of Hg atoms in the ^{3}P state with the ethyl halides is studied in krypton matrix. The primary products result from molecular elimination, though the behavior of ethyl fluoride is different from that of ethyl chloride and bromide in that H_2 elimination is observed exclusively rather than the hydrogen halide elimination that predominates for the other ethyl halides. Some interaction of Hg into C-Cl and C-Br bonds occurs, a process absent in the gas-phase photochemistry.

26267 SiF_4-sensitized decomposition of GeH_4 by a pulsed CO_2 TEA laser. Blazejowski, J. (Pennsylvania State Univ., University Park (USA)); Lampe, F.W. *Journal of Physical Chemistry (USA)*, 93(24): 8038-8045 (30 Nov 1989).

The decomposition of GeH_4, sensitized by multiphoton absorption of unfocused infrared laser radiation by SiF_4, has been studied in the fluence range 0.2-0.9 J/cm^2 and over a total pressure range of 1-70 Torr. Strong absorption of energy from a pulsed CO_2 laser photon field (P40 line; 1027.4 cm^{-1}) and subsequent energy-transfer processes cause an increase in the temperature of the system. As a result of these processes, decomposition of GeH_4 occurs leading to the formation of stoichiometric amounts of metallic germanium and molecular hydrogen. The effects of initial composition, pressure, fluence, and presence of foreign gases (He, H_2) on the yield of GeH_4 decomposition were examined. A reaction model is proposed which assumes that molecules initially present in the absorption volume are heated by the laser pulse and subsequently decompose unimolecularly. Since the decomposition process is exothermic, it prompts a further increase in temperature and thus enhances the decomposition process. Both absorption and decomposition create a shock wave causing expansion of hot gas into cool surrounding volume. The latter process brings about cooling of the hot gas and quenches the decomposition process. Taking into account the above-mentioned effects the temperature profiles (T versus time and geometry of the reaction zone) were evaluated on the basis of statistical thermodynamics, assuming that, at any stage, the system attains thermal equilibrium. Yields of decomposition were then derived with k_{uni} values calculated by the RRKM method. The proposed approach accounts satisfactorily for the experimentally observed dependencies, and we believe it can be generally applied to the description of photosensitized processes in the infrared region.

26268 Hydration of monomeric metaphosphate anion in the gas phase. Keesee, R.G. (Pennsylvania State Univ., University Park (USA)); Castleman, A.W. Jr. *Journal of the American Chemical Society (USA)*, 111(25): 9015-9018 (6 Dec 1989). DOE Contract FG02-88ER60648.

Thermochemical data for the clustering of water molecules onto the monomeric metaphosphate anion PO_3^- in the gas phase are derived from a study by high-pressure mass spectrometry. Experimental details are described, and the enthalpy and entropy changes for the successive addition of the first four water (D_2O) molecules are reported. The results indicate that PO_3^- undergoes simple adduct formation up to the second hydration step, but the third hydration step involves an isomerization of the ion-water cluster into the dihydrate of the dihydrogen orthophosphate anion.

26269 Vibrational characterization of multiply metal-metal bonded osmium, molybdenum, and rhenium porphyrin dimers. Tait, C.D. (Los Alamos National Lab., NM (USA)); Sattelberger, A.P.; Woodruff, W.H.; Garner, J.M.; Collman, J.P. *Journal of the American Chemical Society (USA)*, 111(25): 9072-9077 (6 Dec 1989).

The resonance Raman (RR) scattering and infrared (IR) absorption spectra of $([M(OEP)]_2)^{n+}$ complexes (OEP = 2,3,7,8,12,13,17,18-octaethylporphyrin dianion; M = Os (n = 0-2), Re (n = 0-2), and Mo (n=0)) are reported. Resonance Raman studies reveal the Os-Os stretch to increase in frequency upon oxidation (233 cm^{-1} (n = 0), 254 cm^{-1} (n = 1), and 266 cm^{-1} (n = 2)), consistent with the removal of electrons from π^* metal-metal antibonding orbitals. The Mo-Mo stretch was also observed spectroscopically, producing a RR peak at 341 cm^{-1}, while the Re-Re stretch in $((Re(OEP))_2)^{1+}$ was observed at 290 cm^{-1}. The corresponding metal-metal bond distances estimated from these stretching frequencies are 2.39, 2.31, and 2.27 Å for the osmium oxidation series, 2.23 Å for the molybdenum dimer, and 2.20 Å for the rhenium dimer. The porphyrin-centered vibrational modes (both RR and IR active) for the three osmium complexes are essentially independent of oxidation state, consistent with oxidation of metal-metal antibonding electrons. Little π back-bonding between the metal and porphyrin macrocycle is suggested from porphyrin RR indicator modes, which are sensitive to π electron density. Moreover, the porphyrin core size (center to nitrogen distance) is estimated from core size marker vibrations to be ca. 2.04 Å for all of the complexes studied. Finally, no vibrational evidence for ground-state intradimer coupling between the π orbitals of the porphyrin rings is found.

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Refer also to citation(s) 25559, 25562, 25595, 26148, 26228, 26240, 26247, 26261, 26262, 26301, 26589, 26591, 26786, 27119, 27126, 27135, 27176

26270 (CEA-CONF-9835) **Neutron studies of polymers.** Jannink, G.; Cotton, J.P. Laboratoire Leon Brillouin, Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). 1989. 19p. (CONF-890333--: 9. general conference of the Condensed Matter Division of the European Physical Society, Nice (France), 6-9 Mar 1989). Order Number DE90762052. Available from NTIS (US Sales Only), PC A03/MF A01.

The possibility to contrast given fractions of a polymer system at a cost of a low enthalpy difference is responsible for the success of the neutron method. This approach is especially useful for polymers as compared to colloids or simple liquids, because of the significative intra- and inter-molecular correlations. In this respect,

the pseudo diblock copolymer constitutes one of the best test molecule of homogeneous polymer system. A review is given of main results: polymer size in melts, true backbone conformation and universal constants related to polymer structures. Effects of mechanical stress, of mesogenic order have been revealed. Neutron spin-echo experiments have given characteristic dispersion relations of intra- and inter-polymer diffusive motions. The labelling method is however more powerful than first realized. The amplitude associated with a polymer structure at an interface has been obtained directly (as in ellipsometry) with the use of contrast variation. Such structures are currently investigated by neutron reflectivity. Latest developments are found in the use of spin polarized targets, from which important cross correlations are derived.

26271 (CEA-CONF–9901) **Development of dynamic multicollection for uranium and plutonium analysis in thermal ionisation mass spectrometry.** Dubois, J.C.; Eliot, E.; Retali, G. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Chimie Appliquee et d'Etudes Analytiques. 1989. 10p. (CONF-890565–: 11. annual ESARDA symposium on safeguards and nuclear materials management, Esarda (Luxembourg), 30 May - 1 jun 1989). Order Number DE90762050. Available from NTIS (US Sales Only), PC A02/MF A01.

The use of dynamic multicollection for uranium analysis leads to a correction with respect to the static analysis. This correction does not exist in the plutonium analysis. The analysis of the two compounds is, however, very similar, the main difference lying in the use of the collectors and in the measurement scheme. The isotope U 235 falls in the axial collector. This isotope is used directly during the internal calibration since it is taken into account for correcting the measured sample contribution with respect to the tracer. Our method of internal calibration in the dynamic multicollection mode allow us to eliminate the two main causes of systematic error during the analysis process. The systematic errors are due to isotopic fractionation (principle of internal calibration) and to a poor knowledge of the actual collector gains. Their elimination leads to results that are both accurate and reproducible, i.e. with an accuracy of 0.01%.

26272 (CSIR-SR-SFIS–5, pp. 74-78) **Natural isotopes.** Vogel, J.C. (Council for Scientific and Industrial Research, Pretoria (South Africa). National Physical Research Lab.). Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Production Technology. 1986. In *Annual report July 1985 - June 1986.* Available from the National Physical Research Laboratory, PO Box 395, Pretoria, 0001, South Africa. Available from the National Physical Research Laboratory, PO Box 395, Pretoria, 0001, South Africa.

^{14}C dates between 600 and 900 AD were obtained for early Iron Age sites in Natal, and from 1300 to 1450 AD for rock engraving sites in Bushmanland. Palaeoenvironmental data derived from the dating of samples related to sedimentary and geomorphic features in the central and northern Namib Desert enabled the production of a tentative graph for the changes in humidity in the region over the past 40000 years. These results suggest that relatively humid conditions came to an end in the Namib at ±25000 BP (before present). The increased precision of the SIRA mass spectrometer enabled the remeasurement of ^{13}C and ^{18}O in the Cango stalagmite. This data confirmed that the environmental temperatures in the Southern Cape remained constant to within ±1°C during the past 5500 years. Techniques and applications for environmental isotopes in hydrology were developed to determine the origin and movement of ground water. Isotopic fractionation effects in light elements in nature were investigated. The $^{15}N/^{14}N$ ratio in bones of animals and humans increases in proportion to the aridity of the environment. This suggests that ^{15}N in bone from dated archaeological sites could be used to detect changes in past climatic conditions as naturally formed nitrate minerals are higly soluble and are only preserved in special, very dry environments. The sources and sinks of CO_2 on the South African subcontinent were also determined. The $^{13}C/^{12}C$ ratios of air CO_2 obtained suggest that the vegetation provides the major proportion of respired CO_2. 9 refs., 1 fig.

26273 (DGEN-SI–1) **Determination of Vanadium and Titanium in oil using aqueous calibration curves by X-ray fluorescence.** Ayala, R.E. (Seccion Industrial Direccion General de Energia Nuclear (Guatemala)); Letona, S.M. Direccion General de Energia Nuclear, Guatemala City (Guatemala). Oct 1989. 11p. (In Spanish). Order Number DE90622701. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It is shown that the determination of minor elements in oil can be realized with high accuracy and precision using standard aqueous solutions. The relationship Ii/(Ia-Io)=KCi must be used, where Ii concentration Ci, Ia is the intensity of the scattered radiation of 5.894 keV from a Fe-55 radioisotope source and K is a constant. Io is calculated through the equation Ii/K(Ia-Io)=Ji/K(Ja-Io), where Ii and Ia are measured from the spectrum of an aqueous standard; Ji and Ja are measured from the spectrum of an oil sample, which has a concentration of the element i equal to that in the aqueous solution. The relationship Ii/Ia=KCi, used in previous work, does not include the term Io, therefore it must be used only for semiquantitative analysis. An experiment on the determination of vanadium and titanium in standard oils (CONOSTAN S-12 and CONOSTAN S-21) confirmed this derivation. Reproducibility equal or below 5 and accuracy of 7 were achieved. (author).

26274 (DGEN-SI–2) **Standardization of a sulfur quantitative analysis method by X ray fluorescence in a leaching solution for bio-available sulfates in soil.** Morales S, E. (Seccion Industrial, Direccion General de Energia Nuclear, (Guatemala)); Aguilar S, E. Direccion General de Energia Nuclear, Guatemala City (Guatemala). Nov 1989. 13p. (In Spanish). Order Number DE90622702. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A method for bio-available sulfate analysis in soils is described. A Ca(H2PO4) leaching solution was used for soil samples treatment. A standard NaSO4 solution was used for preparing a calibration curve and also the fundamental parameters method approach was employed. An Am-241 (100 mCi) source and a Si-Li detector were employed. Analysis could be done in 5 minutes; good reproducibility, 5 and accuracy, 5 were obtained. The method is very competitive with conventional nephelometry where good and reproducible suspensions are difficult to obtain. (author).

26275 (DP-MS–88-225) **Determination of Li-Al alloy extent in tubular aluminum elements by small source neutron radiology.** Salaymeh, S.R. (Westinghouse Savannah River Co., Aiken, SC (USA)); Varallo, T.P.; Antal, J.J.; Marotta, A.S. Westinghouse Savannah River Co., Aiken, SC (USA). [1989]. 26p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-890554–4: 3. world conference on neutron radiography, Osaka (Japan), 14-18 May 1989). Order Number DE90009142. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Eddy current is the only nondestructive technique used to determine the extent of the Li–Al alloy in tubular aluminum target tubes. It was desired to have an independent nondestructive method to confirm the extent of the alloy at the tube ends. The method explored and described in this paper is to provide a neutron radioscopic image of 25 cm sections of each tube end. Two small-source neutron radiologic systems were used in this study, a mobile accelerator neutron radiography system and a californium-252 system. These two systems have been shown to provide an accurate alternative method for the determination of the extent of Li–Al alloy in target elements. 8 refs., 6 figs., 1 tab.

26276 (ENEA-RT-COMB–89-02) **HPAT: A nondestructive analysis technique for plutonium and uranium solutions.** Aparo, M.; Mattia, B.; Zeppa, P.; Pagliai, V.; Frazzoli, F.V. ENEA, Casaccia (Italy). Dipt. Ciclo del Combustibile; ENEA, Saluggia (Italy). Centro Ricerche Energia; Rome Univ. (Italy). Dipt. di Energetica. Aug 1989. 25p. (RT/COMB–89-2). Order Number DE90764347. Available from NTIS (US Sales Only), PC A03/MF A01.

Two experimental approaches for the nondestructive characterization of mixed solutions of plutonium and uranium, developed at ENEA (Italian Commission for Alternative Energy Soruces) Research Centre of Casaccia, with the goal of measuring low plutonium concentration (<50 g/1) even in presence of high uranium content, are described in the following. Both methods are referred to as HPAT (Hybrid Passive-Active Technique) since they rely on the measurement of plutonium spontaneous emission in the LX-rays energy region as well as the transmission of KX photons from

the fluorescence induced by a radioisotopic source on a suitable target. Experimental campaignes for the characterization of both techniques have been carried out at EUREX Plant Labs. (Saluggia, Italy) and at Plutonium Plant Labs. (Casaccia, Italy). Experimental results and theoretical value of the errors are reported.

26277 (ENEA-RT-TIB–89-37) **Ion chromatography analysis of stoichiometric relationship of some precursors of superconductor.** Basili, N.; Portaro, N. ENEA, Rome (Italy). Jul 1989. 11p. (In Italian). (RT/TIB–89-37). Order Number DE90764311. Available from NTIS (US Sales Only), PC A03/MF A01.

Recent developments in the field of preparation and sintering of superconductor materials has led to new methods of chemical analysis for the determination of Cu, Ca and Sr. In this paper, two methods are described. In the first, Ca and Sr are determined by ion chromatography with conductometric detection; in the second method, Cu is determined by ion chromatography with post-column reaction and spectrophotometric detection. The results show the reliability and accuracy of the methods.

26278 (ENEA-RT-TIB–89-40) **Purification-materials recovery separtion processes: Highly efficient innovative technological innovations.** Pizzichini, M.; Fabiani, C.; Pilloton, R. ENEA, Casaccia (Italy). Dipt. Tecnologie Intersettoriali di Base. Sep 1989. 58p. (In Italian). (RT/TIB–89-40). Order Number DE90764312. Available from NTIS (US Sales Only), PC A04/MF A01.

Low waste technologies, especially membrane separation technologies, allow the reduction of waste products through the selective recovery of by-products. This paper presents the fundamental properties of membrane technologies such as permeability, selectivity, chemical composition of the polymers, membrane structure and module configuration. Some representative applications of membrane technologies, waste water treatment, water potabilization, ultrapure water production in the medecine and biotechnology fields, are reported. For each practical process, special attention is given to the concept of depuration -recovery. Some practical experiments concerning biogas up-grading, olive water treatment, heavy metal recovery of metal industry wastes (chromate), and diary wastes treatment (whey) are discussed. Membrane processes development represents a real opportunity for the application of innovative technology in many purification processes. In fact, membrane separation processes require low energy consumption (isothermal separation) and allow maximum environmental protection (no pollutants production).

26279 (GKSS–89/E/40) **How to use the features of total reflection of X-rays for energy dispersive XRF.** Schwenke, H. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik); Berneike, W.; Knoth, J.; Weisbrod, U. GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). 1989. 11p. Available from Reprint from: Barrett, C.S.; Gilfrich, J.V.; Jenkins, R.; Huang, T.C.; Predecki, P.K. (eds.): Advances in X-ray analysis, v. 32, Plenum Publishing Corp. (1989) p. 105-114.

The total reflection of X-rays is mainly determined by three parameters, that is the critical angle, the reflectivity and the penetration depth. For X-ray fluorescence analysis the respective characteristic features can be exploited in two rather different fields of application. In the analysis of trace elements in samples placed as thin films on optical flats, detection limits as low as 2 pg or 0.05 ppb, respectively, have been obtained. In addition, a penetration depth in the nanometer regime renders Total Reflection XRF an inherently sensitive method for the element analysis of surfaces. This paper outlines the main physical and constructional parameters for instrumental design and quantitation in both branches of TXRF. (orig.).

26280 (GKSS–89/E/41) **Sample treatment for TXRF - requirements and prospects.** Prange, A. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik); Schwenke, H. GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). 1989. 11p. Available from Reprint from: Barrett, C.S.; Gilfrich, J.V.; Jenkins, R.; Huang, T.C.; Predecki, R.K. (eds.): Advances in X-ray analysis, v. 32, Plenum Publishing Corp. (1989), p. 211-220.

The present paper elucidates the special features of TXRF in view of the requirements for sample preparation for trace element analysis. Based on two examples of application a perspective on sample treatment will be presented which meets these special requirements. (orig.).

26281 (IAEA-AL–23(Rev.1990-01-02)) **A $^{233}U/^{236}U/^{242}Pu/^{244}Pu$ spike for isotopic and isotope dilution analysis by mass spectrometry with internal calibration.** Stepanov, A. (Radievyj Inst., Leningrad (USSR)); Belyaev, B.; Buljanitsa, L. International Atomic Energy Agency, Seibersdorf (Austria). Laboratories. Nov 1989. 99p. Order Number DE90622703. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The Khlopin Radium Institute prepared on behalf of the IAEA a synthetic mixture of ^{233}U, ^{236}U, ^{242}Pu and ^{244}Pu isotopes. The isotopic composition and elemental concentration of uranium and plutonium were certified on the basis of analyses done by four laboratories of the IAEA Network, using mass spectrometry with internal standardization. The certified values for $^{233}U/^{236}U$ ratio and the ^{236}U chemical concentration have a coefficient of variation of 0.05%. The latter is fixed by the uncertainty in the $^{235}U/^{238}U$ ratio of NBS500 used as internal standard. The coefficients of variation of the $^{244}Pu/^{242}Pu$ ratio and the ^{242}Pu chemical concentration are respectively 0.10% and 0.16% and limited by the uncertainty in the $^{240}Pu/^{239}Pu$ ratio of NBS947. This four isotope mixture was used as an internal standard as well as a spike, to analyze 30 batches of LWR spent fuel solutions. The repeatability of the mass spectrometric measurements have a coefficient of variation of 0.025% for the uranium concentration, and of 0.039% for the plutonium concentration. The spiking and treatment errors had a coefficient of variation of 0.048%. (author). Refs, figs and tabs.

26282 (IAEA-TECDOC–537) **Prompt gamma neutron activation analysis in borehole logging and industrial process control: Report of an advisory group meeting held in Vienna, 30 January - 3 February 1989.** International Atomic Energy Agency, Vienna (Austria). Jan 1990. 135p. (CONF-8901184–: Advisory group on prompt gamma neutron activation analysis in borehole logging and industrial process control, Vienna (Austria), 30 Jan - 3 feb 1989). Order Number DE90621001. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Elemental analysis by prompt neutron activation analysis can be made by measuring the energy and intensity of prompt gamma-rays (PGNAA) emitted by an element upon capture of either a thermal or an epithermal neutron. Both prompt gamma-ray methods have a significant potential in bulk analysis because both neutrons and gamma-ray radiation are not significantly attenuated by the sample. The lack of absorption minimizes matrix effects and a large statistically meaningful sample is involved in the analysis. To accomplish the prompt neutron activation analysis in the laboratory it is relatively easy to design and control the entire process. The geometry of measurements is always constant and neutron flux at the sample can be measured. There is practically no restriction on size of detector or neutron source. However, in the narrow confines of a borehole there are a number of restrictions which must be considered. On-line analyses, although not restricted by space, have special problems in biological shielding, timing of detector pulses, need for rapid analysis and sensitivity for a given element. The purpose of this report is to discuss the different features which have to be taken into account when designing a PGNAA analyzer for a borehole logging tool or nuclear process control instrument. The performance characteristics of existing instruments, the special problems, possible solutions and the direction of the current thinking for future research are discussed. In addition, some appropriate applications where these instruments can be beneficially used to solve on-going problems are outlined. Refs, figs, tabs.

26283 (KAERI/MR–140/88) **Service activities of chemical analysis division.** Eom, Tae Yoon (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Suh, Moo Yul; Park, Kyoung Kyun; Jung, Ki Suk; Joe, Kih Soo; Jee, Kwang Yong; Jung, Woo Sik; Sohn, Se Chul; Yeo, In Heong; Han, Sun Ho. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 78p. (In Korean). Order Number DE90622736. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Progress of the Division during the year of 1988 was described on the service activities for various R and D projects carrying out in the Institute, for the fuel fabrication and conversion plant, and for the post-irradiation examination facility. Relevant analytical methodologies developed for the chemical analysis of an irradiated fuel, safeguards chemical analysis, and pool water monitoring were included such as chromatographic separation of lanthanides, polarographic determination of dissolved oxygen in water, and automation on potentiometric titration of uranium. Some of the laboratory manuals revised were also included in this progress report. (Author).

26284 (UCRL-JC-103340) **Thermogravimetric analysis of $Nd_{2-x}Ce_xCuO_{4-\delta}$.** Peng, J.L. (Maryland Univ., College Park, MD (USA). Center for Superconductivity); Greene, R.L.; Klavins, P.; Shelton, R.N.; Radousky, H.B. Lawrence Livermore National Lab., CA (USA). Feb 1990. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-891119-116: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90009184. Available from NTIS, PC A02/MF A01 - OSTI.

Samples of $Nd_{2-x}Ca_xCuO_{4-\delta}$ were prepared by the usual solid state reaction technique and characterized by x-ray diffraction, resistivity, and magnetization measurements. The thermogravimetric analysis (TGA) was used to observe the sample weight change as a function of temperature in a variety of gas atmosphere. he oxygen content was determined by a TGA technique in corporating with results of x-ray diffraction. We confirmed that for x = 0.15, a small value of δ (of order 0.05) is vital to superconductivity. 8 refs., 4 figs.

26285 Structural changes in Ag, Fe, Mn, and Ge microclusters. Zhao, J. (Dept. of Physics, W. Virginia Univ., Morgantown, WV (US)); Ramanathan, M.; Montano, P.A.; Shenoy, G.K.; Schulze, W. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811224--: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

The authors report the structures of Ag, Fe, Mn, and Ge microclusters determined using EXAFS. The measurements were performed over a wide range of clusters sizes. The clusters were prepared using the gas aggregation technique and isolated in solid argon at 4.2 K. A strong contraction of the interatomic distances was observed for Ag dimers and multimers. Silver clusters larger than 17 Å mean diameter show a small contraction of the nn distance and structure consistent with an fcc lattice. By contrast smaller clusters show the presence of a small expansion and a strong reduction or absence of nnn in the EXAFS signal. This points towards a different crystallographic structure for Ag microclusters.

26286 Fluoresence yield near edge spectroscopy (FYNES) for ultra low Z materials: An in-situ probe of reaction rates and local structure. Fischer, D.A. (Exxon PRT, Brookhaven National Lab., Upton, NY (US)); Gland, J.L.; Meitzner, G. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811224--: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

Fluorescence Yield Near Edge Spectroscopy (FYNES) of ultra low Z materials represents a synchrotron radiation milestone for in-situ determination of local structure for a range of materials problems from monolayers to bulk samples even in the presence of a reactive atmosphere. Two examples are presented highlighting the broad range of materials problems addressed by the FYNES technique. First a study of the kinetics of CO displacement on Ni(100) by hydrogen at pressures up to .1 torr. These kinetic results highlight the unique capabilities of FYNES to directly characterize surface reaction rates in the presence of reactive gases. Second, a pioneering fluorescence EXAFS study characterizing low concentration fluorine materials is discussed. Opportunities in FYNES presented by increased photon flux from insertion-device-based sources are explored.

26287 EXAFS studied of multilayer interfaces. Heald, S.M. (Brookhaven Lab., Upton, NY (US)); Lamble, G.M. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811224--: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

Important for the understanding of multilayer materials is a determination of their structure. The extended x-ray absorption fine structure (EXAFS) technique can be useful, particularly for interfaces with a high degree of structural disorder. This paper reviews the application of EXAFS to multilayers, and describe the standing wave enhancement of the EXAFS from multilayer interfaces. Examples are given for W-C and Ni-Ti multilayers.

26288 Interaction of thin Ga overlayer with InP(110): A photoemission study. Cao, R. (Stanford Eelctronics Lab., Stanford Univ., Stanford, CA (US)); Miyano, K.; Kendelewicz, T.; Lindau, I.; Spicer, W.E. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811224--: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

Photoemission study of the Ga/InP(110) interface, in particular at the In 4d cooper minimum (CM) reveals that the growth of the deposited Ga on InP(110) at room temperature (RT) has two modes: chemisorption at low coverage and metallic island formation at high coverage, whereas the Ga overlayer is much more uniform at 80K low temperature (LT). A replacement reaction between Ga and InP is found to take place only underneath the Ga islands. Metal screening from Ga islands is suggested to weaken the substrate bonds and enhance the replacement reaction. Distinct behavior of Fermi level pinning has been observed at different temperatures. This correlation with the temperature dependence of the overlayer morphology as well as the interfacial reaction.

26289 The bonding in beta-rhombohedral boron. Wong, J. (Lawrence Livermore National Lab., Livermore, CA (US)); Slack, G. A. pp. 304 of Synchrotron radiation in materials research. . Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8811224--: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

The boding and local atomic structure of a series of 3d metal-beta boron solid solution are investigated using a combination of x-ray absorption near-edge structure (XANES) and extended fine structure (EXAFS) technique utilizing intense synchrotron radiation as a light source. The corresponding metal diborides MB_2, (M = Sc, Ti, V, Cr) were also measured and used to model the coordination environment of these metal sites in beta-boron. The XANES spectral variation are also studied as a function of dopant concentration for the case of Ti, V, Cr, Fe, Co, Ni and Cu. Doubly doped (V/Cu) system is studied and compared with the singly-doped V and Cu materials.

26290 EXAFS of near monolayer and submonolayer coverage films. Barbee, T W., Jr. (Lawrence Livermore National Lab., Livermore, CA (US)); Wong, J. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8811224--: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

The high intensities available using synchrotron source insertion devices potentially extend the range of adatom surface coverage on well prepared surfaces that may be experimentally studied to very low levels. In this paper the authors report the results of a fluorescence EXAFS study of a 0.5 nm thick hafnium film in the vicinity of its L_{III} absorption edge (9561 eV). This film was deposited on a platinum-carbon multilayer having a period of 31.7Å. These results indicate that EXAFS studies of species at surface coverages of 0.01 monolayer are easily experimentally accessible.

26291 Time-resolved small angle x-ray scattering and dynamic light scattering studies of sol-gel transition in gelatin. Wu, D.A. (Dept. of Chemistry, State Univ. of New York at Stony Brook, Long Island, NY (US)); Chu, B. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811224--: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

The authors describe structural and dynamic properties of an aqueous gelatin solution in a sol-gel transition studied by time-resolved small angle x-ray scattering (SAXS) and dynamic light scattering (DLS) after quenching the gelatin sol. SAXS intensity measurements suggested the presence of gel fibrils which grew initially in cross-section. The average cross-section of the gel fibrils reached a constant value after an initial growth period of 800 sec. Further increase in SAXS intensity could be attributed to the increase in the length of the gel fibrils. Photo correlation, on the other hand, clearly showed two relaxation modes on both the sol and the gel states: a fast cooperative diffusion mode which remained constant from the sol to the gel state after correction for the temperature dependence of the solvent viscosity; and a slow mode that could be attributed to the self-diffusion of the free gelatin chains and aggregates.

26292 Automatic orientation mapping with synchrotron radiation. Gottstein, G. (Dept. of Metallurgy, Mechanics & Materials Science, Michigan State Univ., East Lansing, MI (US)). pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

Synchrotron radiation can be utilized to obtain Laue back reflection patterns of microscopic areas with very short exposure time. A method is presented to fully automatically evaluate Laue patterns. The experimental setup and procedure are outlined to determine the orientations of a large number of contiguous grains, and consequently to enable orientation mapping. Preliminary experimental results are presented.

26293 Reflectivity of soft x-rays by polymer mixtures. Russell, T.P. (IBM Research Div. Almaden Research Center, San Jose, CA (US)); Stohr, J.; Jack, W.; Comelli, G. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

The authors discuss the specular reflectivity of soft x-rays used to investigate the surface behavior mixtures of poly(vinylidene fluoride), PVF_2 and poly(methyl methacrylate), PMMA. Mixtures where the concentration of PMMA is 0.8 where investigated as a function of the preparation and annealing conditions. It was found that mixtures prepared by rapidly casting from dimethylformamide, DMF, exhibited a gradient in the concentration of the two components. The gradient extended over large distances and was such that PMMA, the higher surface energy component was located preferentially at the surface. With annealing at 165°C, the width of the gradient diminished but the concentration of PMMA remained high at the surface. Films of the mixture prepared under a slower solvent evaporation procedure produced a reflectivity profile characteristic of a phase separated mixture.

26294 X-ray fluorescence microprobe imaging with undulator radiation. Rivers, M.L. (Dept. of the Geophysical Sciences, The Univ. of Chicago, Chicago, IL (US)); Sutton, S.R.; Gordon, B.M. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC02-76CH00016. (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

The authors report synchrotron x-ray fluorescence experiments performed using a prototype undulator for the Advanced Photon Source installed on the CESR storage ring at Cornell University. Fluorescence spectra were collected from a number of standard references and unknowns. Thick target minimum detectable limits (MDL) were about a factor of two higher than those obtained using white bending magnet radiation at the NSLS. The higher MDLs could be due to lower polarization and/or imperfect alignment of the Si(Li) detector. Thin target MDLs were about 10 times lower than the NSLS since the undulator produced a unusable spot size which was also 10 times smaller. These experiments demonstrate that undulators on the proposed Advanced Photon Source will be ideal for a trace element x-ray fluorescence microprobe with excellent elemental sensitivity and spatial resolution.

26295 X-ray microprobe for the microcharacterization of materials. Sparks, C.J. (Metals and Ceramics Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Ice, G.E. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

The authors discuss the unique properties of X rays offer many advantages over those of electrons and other charged particles for the microcharacterization of materials. X rays are more efficient in exciting characteristic X-ray fluorescence and produce higher fluorescence signal-to-background ratios than obtained with electrons. High brightness storage rings, especially in the 7 GeV class with undulators, will have sources as brilliant as the most advanced electron probes. The highly collimated X-ray beams from undulators simplify the X-ray optics required to produce submicron X-ray probes with fluxes comparable to electron sources. Such X-ray microprobes will also produce unprecedentedly low levels of detection in diffraction, EXAFS, Auger, and photoelectron spectroscopies for structural and chemical characterization and elemental identification.

26296 Dispersive x-ray synchrotron studies of Pt-C multilayers. Rodricks, B. (Dept. of Physics, The Univ. of Michigan, Ann Arbor, MI (US)); Lamelas, F.; Medjahed, D.; Passos, W.; Clarke. R.; Smither, R.; Fontaine, A.; Ziegler, E. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J. H. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-31109-ENG-38. (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

The authors demonstrate the simultaneous acquisition of high-resolution x-ray absorption spectra and scattering data, using a combination of energy-dispersive optics and a two-dimensional CCD detector. Results are presented on the optical constants of Pt and on the reflectivity of a platinum-carbon multilayer at the L_{III} absorption edge of Pt. Using this information they compare the measured glancing-angle reflectivity with values calculated using an iterative Fresnel method.

26297 Mass mapping with the scanning transmission electron microscope. Wall, J.S. (Brookhaven National Lab., Upton, NY (USA)); Hainfeld, J.F. *Annual Review of Biophysics and Biophysical Chemistry (USA)*, 15: 355-376 (1986). DOE Contract AC02-76CH00016.

The past few years have witnessed an explosion in the productivity of the scanning transmission electron microscopy (STEM). With the food of specimens have come significant improvements in techniques of specimen preparation and image analysis. However, the full potential of the instrument for solving problems in structural biology is still far from realization. We predict that in the next few years the STEM will move gradually into the niche now occupied solely by x-ray and neutron diffraction.

26298 Inelastic neutron-scattering study of $K[HCo_6(CO)_{15}]$: Implications for location of the hydride. Eckert, J. (Los Alamos National Lab., NM (USA)); Albinati, A.; Longoni, G. *Inorganic Chemistry (USA)*, 28(21): 4055-4056 (18 Oct 1989).

Inelastic neutron-scattering (INS) studies of $K[HCo_6(CO)_{15}]$ were undertaken to attempt to resolve the apparent discrepancy between the previously reported INS studies of Graham et al and Stanghellini and Longoni. INS spectra for both the hydrogenated and deuterated compounds were analyzed. It is concluded that more than half of the hydrogen in $K[HCo_6(CO)_{15}]$ is located in the interstitial site with the rest most likely in either μ_2-H or μ_3-H form on the inner (or possibly outside) of the Co cluster. The results reported here are in substantial agreement with those vibrational features that were unambiguously assigned to ν (Co-H) in the IR work of Stanghellini and Longoni. The vibrational bands in the 1050-1100 cm^{-1} region are thought to be most likely associated with μ_6-H in these octahedral Co clusters. 14 refs., 1 fig.

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Refer also to citation(s) 25310, 25407, 26118, 26119, 26120, 26121, 26123, 26151, 26158, 26235, 26236, 26237, 26238, 26239,

26241, 26242, 26243, 26245, 26248, 26250, 26251, 26252, 26253, 26254, 26258, 26259, 26260, 26263, 26264, 26265, 26268, 26269, 26277, 26286, 26349, 26359, 26364, 26372, 26589, 26590, 26595, 26596, 26597, 26600, 26853, 26882, 27008, 27009, 27010, 27045

26299 (IC–89/361) **Thermodynamics of simple liquid metals calculated using an analytic pair potential.** Khajil, T.M.A.; Tomak, M. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 10p. Order Number DE90622744. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Pettifor-Ward analytic pair potential parameters are rederived for liquid metals Li, Na, K, Rb, Cs, Mg and Al. The analytic pair potentials are used to calculate the thermodynamic properties. (author). 8 refs, 1 fig., 5 tabs.

26300 (KAERI/RR–791/88) **A study on the adsorption mechanism of elemental iodine and methyl iodide on the activated carbon.** Chang, Kil Sang (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Park, Geun Il; Cheong, Myeong Soo; Chun, Kwan Sik. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Feb 1989. 70p. (In Korean). Order Number DE90622745. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The purpose of the study lies in the examination of the removal efficiency of activated carbon for elemental iodine and methyliodide. By the adsorption experiments of elemental iodine and methyliodide on an unimpregnated activated carbon fixed bed adsorber, various breakthrough curves are analyzed with respect to the changes of feed concentration, flow rate and bed depth. For the mathematical approach of very stiff fixed bed adsorber system, analytical solution for the linear equilibrium isotherm has been applied to the present nonlinear isotherm case by modifying the adsorption rate constant. By the close examination of analytical and experimental results, the adsorption efficiency of elemental iodine on an unimpregnated activated carbon was proved superior to that of methyliodide, and this is more distinct at low concentrations. The adsorbed elemental iodine remains stable in the charcoal as the forms of I_2 or I_3^- and are not desorbed readily. Meanwhile, methyliodide shows comparatively low adsorption capacity and can be desorbed easily by the change of ambient condition. (Author).

26301 (LBL–28289) **[8]Annulene derivatives of cerium.** Rigsbee, J.T. Jr. Lawrence Berkeley Lab., CA (USA). Aug 1988. 188p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90009197. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

A study has been performed on bis[8]annulene complexes of cerium, focusing primarily on tetravalent cerium. This unusual compound, cerocene, was originally prepared using a low yield, specific synthesis; a more general synthesis has now been found. It has been determined that treating a solution of the readily prepared $K[Ce(C_8H_8)_2]$ with an excess of silver iodide results in a high yield of the corresponding tetravalent cerium sandwich compound. This method has now been used to successfully prepare several substituted analogs in equally good yield. The chemistry of this class of molecule has been explored using a variety of physical techniques. Variable temperature ^1H NMR shows an electron exchange on the NMR timescale, as has been observed for similar metallocenes. An examination of the visible spectrum of this molecule showed agreement with the previously calculated energy for this transition. The electrochemistry of these molecules has also been examined and the Ce(IV)/Ce(III) reduction potential was measured to be −1.3 V; this value is extremely low for a cerium species and suggests that a considerable amount of stability is being imparted by the COT rings. The crystal structure of dimethylcerocene has now been solved. In general, the structure shows the features expected for this class of molecule, but there are several interesting features which are discussed. Efforts have also been made to prepare another ligand, 1,3,5 7-tetramethylcyclooctatetraene are described as well. 173 refs., 28 figs., 14 tabs.

26302 Some developments in nuclear magnetic resonance of solids. Chmelka, B.F. (Lawrence Berkeley Lab., CA (USA)); Pines, A. *Science (Washington, D.C.) (USA),* 246(4926): 71-77 (6 Oct 1989).

Nuclear magnetic resonance (NMR) spectroscopy continues to evolve as a primary technique in the study of solids. This review briefly describes some developments in modern NMR that demonstrate its exciting potential as an analytical tool in fields as diverse as physics, chemistry, biology, geology, and materials science. Topics covered include motional narrowing by sample reorientation, multiple-quantum and overtone spectroscopy, probing porous solids with guest atoms and molecules, two-dimensional NMR studies of chemical exchange and spin diffusion, experiments at extreme temperatures, NMR imaging of solid materials, and low-frequency and zero-field magnetic resonance. These developments permit increasingly complex structural and dynamical behavior to be probed at a molecular level and thus add to our understanding of macroscopic properties of materials. 59 refs., 12 figs.

26303 Indirect detection methods: Looking for what is not there. Yeung, E.S. (Ames Lab., IA (USA)). *Accounts of Chemical Research (USA),* 22(4): 125-130 (Apr 1989). DOE Contract W-7405-ENG-82.

Indirect detection allows one to monitor species that normally do not give a response. It has grown from an intellectual curiosity to become an extremely useful tool. For volume displacement, polarimetry gives the best results. For charge displacement, ion chromatography and capillary zone electrophoresis are ideal situations for applying indirect fluorescence detection. LOD surpasses all but the most specialized detection schemes. Future developments in systems specially designed for indirect detection should make these schemes even more powerful.

26304 Systems analysis at the molecular scale. Rabitz, H. (Princeton Univ., NJ (USA)). *Science (Washington, D.C.) (USA),* 246(4927): 221-226 (13 Oct 1989).

Problems involving physiochemical phenomena on both the microscopic and macroscopic scales often raise similar sets of generic issues and questions. The complexity of these problems is beginning to make inoperative the traditional intuition-based approaches to their analysis and solution. The common characteristics of large, multivariable, complex molecular systems call for a new, more systematic approach to guide theoretical and experimental efforts. With mathematical modeling becoming an essential ingredient in the studies, it is argued that molecular systems analysis and especially the systematic tools of sensitivity analysis can play an increasingly important role in understanding and finding solutions to complex, chemically based problems. 27 refs., 5 figs.

26305 Far-infrared laser spectroscopy of van der Waals bonds: A powerful new probe of intermolecular forces. Saykally, R.J. (Lawrence Berkeley Lab., CA (USA)). *Accounts of Chemical Research (USA),* 22(9): 295-300 (Sep 1989). DOE Contract AC03-76SF00098.

Our objective in these studies is to provide a detailed characterization of the structures and internal dynamics of weakly bound complexes as the requisite first step toward the ultimate goal: obtaining details three-dimensional intermolecular potential-energy surfaces for molecular weak interactions. The current state of the art limits us to studies of binary systems, but several groups are currently seeking to extend both the theory and experiments to address ternary and quaternary complexes. This will afford a detailed examination of the many-body effects (e.g., Axelrod -Teller triple dipole dispersion interaction), which becomes of potential importance in models of the chemistry of liquids.

26306 Catalytic antibodies. Schultz, P.G. (Univ. of California, Berkeley (USA)). *Accounts of Chemical Research (USA),* 22(8): 287-294 (Aug 1989).

In the short period of time that has elapsed since the first reports of antibody catalysis in 1986, a considerable number of different reactions have been catalyzed by using antibodies. The specificities of catalytic antibodies are high, and rate enhancements approaching those of enzymes have been demonstrated. A number of general strategies have also evolved for generating catalytic antibodies. The development of antibodies with 10^8-fold or higher rate enhancements will require careful mechanistic analysis of those factors affecting antibody catalysis and the generation of antibodies which combine several of these features. This process not only will provide new insight into the nature of molecular recognition and

catalysis but also may afford tailor-made catalysts for applications in chemistry, biology, and medicine.

26307 Absolute rate expressions for the abstraction of hydrogen by primary, secondary, and tertiary alkyl radicals from thiophenol. Franz, J.A. (Pacific Northwest Lab., Richland, WA (USA)); Bushaw, B.A.; Alnajjar, M.S. *Journal of the American Chemical Society (USA),* 111(1): 268-275 (4 Jan 1989). DOE Contract AC06-76RL01830.

Absolute rate expressions for the abstraction of hydrogen from thiophenol in nonane by tert-butyl, isopropyl, n-butyl, and n-octyl radicals were determined by kinetic absorption spectroscopy (KAS). Alkyl radicals were produced by photolysis of dialkyl disulfides or by photolysis of mixtures of di-tert-butyl peroxide and trialkylphosphine in the presence of thiophenol. Arrhenium expressions for alkyl radicals from the phosphine method from 225 to 355 K were as follows: n-butyl, log ($k/M^{-1}\ s^{-1}$) = (9.40 ± 0.13) - (1.74 ± 0.21)/θ, θ = 2.303RT kcal/mol; isopropyl, log ($k/M^{-1}\ s^{-1}$) = (9.26 ± 0.19) - (1.70 ± 0.21)/θ; tert-butyl, log ($k/M^{-1}\ s^{-1}$) = (9.26 ± 0.26) - (1.50 ± 0.20)/θ. Rate constants at 298 K vary from 0.8 x 10^8 to 1.5 x 10^8 $M^{-1}\ s^{-1}$ for the hydrogen-transfer reactions. 32 refs., 2 figs., 2 tabs.

26308 Solubility product and thermodynamic functions for the holmium trifluoride - water system. Menon, M.P. (Savannah State College, GA (USA)); James, J.; Hill, T.L. *Georgia Journal of Science (USA),* 46(4): 231-238 (1988). DOE Contract FG09-84SR14014.

The total solubility, free ion concentrations in saturated solutions, solubility products and thermodynamic functions for the dissolution of holmium trifluoride hemihydrate together with the stability constants for the holmium mono- and difluoride complexes are reported in this paper. Conductometric and potentiometric methods were used to measure the solubilities for comparison of the results obtained therefrom. Our values for pK_{SO}, the thermodynamic solubility product in terms of free ion concentrations of both ions, obtained from both methods are in agreement with one of the reported values. There are no values reported in the literature for the thermodynamic constants for the dissolution process to be compared with except for entropy change. Our values for the stability constants, measured by a simplified procedure, do not agree with those reported by previous authors.

26309 Surface and internal excess electron states in molecular clusters. Barnett, R.N. (Georgia Institute of Technology, Atlanta (USA)); Landman, U.; Scharf, D.; Jortner, J. *Accounts of Chemical Research (USA),* 22(10): 350-357 (Oct 1989). DOE Contract FG05-86ER45234.

Clusters, i.e., finite aggregates containing 2-10^4 atomic or molecular constituents, exhibit unique physical and chemical phenomena, which provide ways and means to explore the gradual transition from molecular to condensed-matter systems. Furthermore, the large surface-to-volume ratio in clusters allows for the exploration of microscopic surface phenomena. The progress in our understanding of the evaluation of quantum, thermodynamic, dynamic, and chemical size effects in clusters is expected to provide a unified interrelationship between molecular, surface, and bulk phenomena in large finite systems. The authors shall be concerned with the structural and dynamic implications of electron attachment to nonmetallic molecular clusters. We have recently utilized the QUPID method to explore the compositional, structural, and size dependence of electron localization in ionic and hydrogen-bonded clusters, which provide novel information regarding three central phenomena.

26310 Coulomb explosion imaging of small molecules. Vager, Z. (Weizmann Institute of Science, Rehovot (Israel)); Naaman, R.; Kanter, E.P. *Science (Washington, D.C.) (USA),* 244(4903): 426-431 (28 Apr 1989). DOE Contract W-31-109-ENG-38.

Most of our knowledge of the structures of free molecules comes from indirect observations that focus on other properties (for example, energy or mass spectra) that depend on structure. Recently, a new method has been developed that instead yields geometrical images of individual molecules. This method takes advantage of the large Coulomb repulsion of the nuclei within molecules rapidly stripped of their electrons. The first experiments with this new technique have already revealed structural images of several important species, such as positively charged methane ions. 36 refs., 4 figs.

26311 A chemical exchange system for isotopic feed to a nitrogen and oxygen isotope separation plant. Mills, T.R. (Los Alamos National Lab., NM (USA)); Garcia, M.G.; Vandervoort, R.C.; McInteer, B.B. *Separation Science and Technology (USA),* 24(5-6): 415-428 (Apr-May 1989).

A process has been developed to provide isotopic feed to a nitric oxide isotope distillation plant. Central to the process is the isotopic chemical exchange of NO and nitric acid in countercurrent flows in a 3-in. diameter packed column. An isotopically depleted stream of NO is reenriched to natural isotopic abundances by the exchange and is recycled as feed back to the distillation columns. Makeup NO is generated in another column from sulfur dioxide and nitric acid. Multistage gas purifiers reduce condensible impurities in the nitric oxide below 10 ppm. The process operates unattended at flow rates of 0.5 to 2 mol/min. The new NO recycle-enrichment and generation processes have successfully provided the feedstock for the NO isotope separation columns for over 6 years. 19 refs., 2 figs.

26312 Disorder-to-order transition in settling suspensions of colloidal silica: X-ray measurements. Davis, K.E. (Princeton Univ., NJ (USA)); Russel, W.B.; Glantschnig, W.J. *Science (Washington, D.C.) (USA),* 245(4917): 507-510 (4 Aug 1989). DOE Contract FG02-85ER45210.

Dispersions of colloidal particles exhibit thermodynamic properties similar to those of molecular systems, including a hard sphere disorder-to-order transition. In experiments with organophilic silica in cyclohexane, gravity settling was used to concentrate the particles. With small particles the slow sedimentation permits rearrangement into the iridescent ordered phase, but larger particles form amorphous sediments instead. Scanning electron microscopy of the crystalline sediment indicates hexagonally close-packed layers. X-ray attenuation measurements reveal a discontinuity coincident with the observed boundary between iridescent and opaque regions. Sediments accumulating faster than the maximum rate of crystallization produce a glass, in accord with the classical theory for crystal growth. 15 refs., 4 figs.

26313 Physicochemical properties of supported γAl_2O_3 and TiO_2 ceramic membranes. Moosemiller, M.D. (Univ. of Wisconsin, Madison (USA)); Hill, C.G. Jr.; Anderson, M.A. *Separation Science and Technology (USA),* 24(9-10): 641-657 (Jul-Aug 1989).

Supported γ-Al_2O_3 and TiO_2 ceramic membranes were prepared by sol-gel techniques from alkoxide precursors. Tests were conducted to measure the permeabilities of these membranes to solvent under a variety of operating conditions. Variables studied were feed temperature, length of time on stream, and feed pH. The stabilities of the membranes in harsh chemical environments were also determined. An alternative method for preparing supported ceramic membranes is also suggested. 10 refs., 10 figs., 2 tabs.

26314 Orthogonal self-assembled monolayers: Alkanethiols on gold and alkane carboxylic acids on alumina. Laibinis, P.E. (Harvard Univ., Cambridge, MA (USA)); Whitesides, G.M.; Hickman, J.J.; Wrighton, M.S. *Science (Washington, D.C.) (USA),* 245(4920): 845-847 (25 Aug 1989).

This work demonstrates the practicality of forming two self-assembled monolayers (SAMs), independently but simultaneously, by adsorption of two different adsorbates from a common solution onto a substrate exposing two different materials at its surface. The experimental procedure and the degree of independence achieved in the resulting SAMs are illustrated by examination of monolayers obtained by adsorption of alkanethiols on gold and alkane carboxylic acids on alumina. This procedure provides a method for modifying the surface characteristics of microlithographically generated patterns and offers a versatile technique for controlling solid-vapor and solid-liquid interfacial properties in systems having patterns with dimensions of the order of 1 micrometer. 15 refs., 2 figs.

26315 Molecular recognition and metal ion template synthesis. McMurry, T.J. (National Cancer Institute, Bethesda, MD

(USA)); Raymond, K.N.; Smith, P.H. *Science (Washington, D.C.) (USA)*, 244(4907): 938-943 (26 May 1989).

Methods for the design and synthesis of ligands intended to be specific for a metal ion have been a recent chemical development. This article describes how this process can be inverted so that the specifics of the coordination environment around the metal ion can be used as a template in large-scale ligand synthesis. The synthesis of macrobicyclic ligands for ferric ion has been accomplished by using active esters of catechol ligands in which catacholate coordination to iron is a prelude to the organic chemical reactions that link the coordination subunits together into one ligand system surrounding a central metal ion coordination site. The lanthanide(III) ions, which are among the most labile metal ions known, have coordination numbers of 8 or higher, and thus their encapsulation into a macrobicyclic structure is a challenging problem. Lanthanide amine complexes have been used as metal templates in the synthesis of such macrobicyclic lanthanide complexes. There is evidence that such a complex is inert to exchange in aqueous solution. 46 refs., 4 figs.

26316 Shear forces in molecularly thin films. Schoen, M. (Universitaet Witten-Herdecke, Stockumer Strasse (Germany, F.R.)); Rhykerd, C.L. Jr.; Diestler, D.J.; Cushman, J.H. *Science (Washington, D.C.) (USA)*, 245(4923): 1223-1225 (15 Sep 1989). DOE Contract FG02-85ER60310.

Monte Carlo and molecular dynamics methods have been used to study the shearing behavior of an atomic fluid between two plane-parallel solid surfaces having the face-centered cubic (100) structure. A distorted, face-centered cubic solid can form epitaxially between surfaces that are separated by distances of one to five atomic diameters. Under these conditions a critical stress must be overcome to initiate sliding of the surfaces over one another at fixed separation, temperature, and chemical potential. As sliding begins, a layer of solid exits the space between the surfaces and the remaining layers become fluid. 18 refs., 2 figs.

26317 Alkane functionalization on a preparative scale by mercury-photosensitized cross-dehydrodimerization. Brown, S.H. (Yale Univ., New Haven, CT (USA)); Crabtree, R.H. *Journal of the American Chemical Society (USA)*, 111(8): 2946-2953 (12 Apr 1989).

Alkanes can be functionalized with high conversions and in high chemical and quantum yields on a multigram scale by mercury-photosensitized reaction between an alkane and alcohols, ethers, or silanes to give homodimers and cross-dehydrodimers. The separation of the product mixtures is often particularly easy because of the great difference in polarity of the homodimers and cross-dimers. It is also possible to bias the product composition when the ratio of the components in the vapor phase is adjusted by altering the liquid composition. This is useful either to maximize chemical yield or to ease separation by favoring the formation of the most easily separated pair of compounds. The mechanistic basis of the reaction is discussed and a number of specific types of syntheses, for example of 2,2-disubstituted carbinols, are described in detail. The selectivity of cross-dimerization is shown to exceed that for homodimerization and reasons are discussed. Relative reactivities of different compounds and classes of compound are MeOH < p-dioxane < cyclohexane < 1,3,5-trioxacyclohexane < ethanol < isobutane < THF < Et_3SiH. The observed selectivities generally parallel those for homodimerization, reported in the preceding paper, but certain differences are noted, and reasons for the differences are proposed. The bond-dissociation energy of Et_3SiH is estimated from the reactivity data to be 90 kcal/mol. Eleven new carbinols are synthesized. 39 refs., 6 tabs.

26318 Structures and energies of the tautomers and conjugate bases of some 1,2,4-triazolones. Ritchie, J.P. (Los Alamos National Lab., NM (USA)). *Journal of Organic Chemistry (USA)*, 54(15): 3553-3560 (21 Jul 1989).

Molecular orbital calculations at the AM1, 3-21G//3-21G, and 6-31G*//3-21G levels were performed for several possible tautomers of 1,2,4-triazol-5-one and 3-nitro-1,2,4-triazol-5-one. Calculations were also performed at the AM1, 3-21G//3-21G, and 6-31+G//3-21G levels for some conjugate bases of these compounds. The results show the 1H, 4H tautomer to be most stable. 5-hydroxy-1H-1,2,4-triazole and 3-nitro-5-hydroxy-1H-1,2,4-triazole are found to lie 9.4 and 7.5 kcal/mol, respectively, higher in energy than the corresponding 1H, 4H isomer. It is believed that the calculations may overestimate this relative energy by perhaps 1-3 kcal/mol. The calculations also predict that deprotonation is most likely at N_4 of the lowest energy triazolone, but nearly equally likely at N_1 and N_4 for the corresponding nitrotriazolone (although the N_4 position is slightly favored). We also examined the substitution effects of the nitro group of comparing calculated geometries, relative energies, and electrostatic potentials of the triazolones and nitrotriazolones. Electronegativity effects predominate for the neutral compounds. In the conjugate bases, a significant contribution from resonance participation of the nitro group was found. Finally, we point out some problems in using the electrostatic potential to predict the site of electrophilic substitution in the triazolone.

26319 Competition between birch reduction and bond cleavage in 1,2-bis(4-methyl-1-naphthyl)ethane. Marcinow, Z. (Indiana Univ.-Purdue Univ., Indianapolis (USA)); Hull, C.E.; Rabideau, P.W. *Journal of Organic Chemistry (USA)*, 54(15): 3602-3605 (21 Jul 1989).

The reaction of 1,2-bis(4-methyl-1-naphthyl)ethane with Li, Na, and K in ammonia, THF, and HMPA, or mixtures thereof, has been examined with respect to the factors favoring Birch reduction of the aromatic ring and cleavage of the ethane carbon-carbon bond. Bond cleavage was found to increase relative to ring reduction in the series Li < Na < K and with the solvents NH_3 < THF < HMPA. However, the latter position of ammonia may be due to the necessarily restricted low-reaction temperature since only ring reduction was observed at temperatures at or below the boiling point of ammonia (-33°C). A number of reduction and cleavage products were isolated and identified, and the mechanistic pathways for their formation is discussed.

26320 Preparation, characterization, and chemistry of $F_4S{=}CCF_2OSO_2$. Winter, R. (Portland State Univ., OR (USA)); Peyton, D.H.; Gard, G.L. *Inorganic Chemistry (USA)*, 28(19): 3766-3770 (20 Sep 1989). DOE Contract FG21-88MC25142.

Dehydrohalogenation of the sultone $F_5SCHSF_2OSO_2$ with the base $F_3B{\cdot}N(C_2H_5)_3$ was found to yield a mixture of the ketene $F_5SC(SO_2)F{=}C{=}O$ (1) and its isomer $F_4S{=}CCF_2OSO_2$ (2). Experimental conditions did not seem to alter the ratio of these compounds in the product, and the separation of 1 and 2 was found to be very difficult. It was found that treatment of the mixture with CsF resulted in the removal of 1 with recovery of 2. Treatment of the mixture of 1 and 2 with the CsF resulted in the formation of $Cs^+[F_5S(SO_2F)COF]^-$, which was characterized by ^{19}F NMR spectroscopy. The reactions of 1 and 2 with HCl and HF are also reported. ^{13}C NMR spectroscopy was also used to characterize 1. 18 refs., 1 fig.

26321 Effect of steric crowding on the rates of reactions of a nickel(I) tetraaza macrocycle with organic halides and hydroperoxides. Sadler, N. (Ames Lab., IA (USA)); Scott, S.L.; Bakac, A.; Espenson, J.H.; Ram, M.S. *Inorganic Chemistry (USA)*, 28(21): 3951-3954 (18 Oct 1989). DOE Contract W-7405-ENG-82.

The reactions of the sterically crowded decamethylcyclam complex of nickel(I), $Ni(dmc)^+$ (dmc = decamethylated macrocycles), with organic halides, hydrogen peroxide, and tert-butyl hydroperoxide occur some 10^4 times more slowly than the corresponding reactions of $Ni(tmc)^+$ (tmc = tetramethyllated macrocycles), a tetramethylcyclam complex. This supports the assignment of an inner-sphere mechanism in both cases, because reactions that necessarily adopt an outer-sphere mechanism (e.g., those of cobalt(III) amine complexes) differ no more in their relative rates than can easily be explained by the small difference in driving force. 29 refs., 5 figs., 2 tabs.

26322 MLCT excited states. Role of the hydrido ligand in hydrido polypyridyl complexes of osmium(II) and ruthenium(II). Megehee, E.G. (Univ. of North Carolina, Chapel Hill (USA)); Meyer, T.J. *Inorganic Chemistry (USA)*, 28(22): 4084-4091 (1 Nov 1989).

The photochemical and photophysical properties of the complexes $[M(bpy)_2(CO)X]PF_6$ (bpy = 2,2′-bipyridine; M = Os, X = H, D, Cl; M = Ru, X = H, D) are reported in 4:1 ethanol/methanol solution from 90 to 300 K. Metal to ligand charge-transfer (MLCT)

excitation fails to induce metal hydride photochemistry, but oxidative or reductive quenching of $[Os(bpy)_2(CO)H]^{++}$ does induce a net redox chemistry. There is no evidence for significant contributions to the emission spectrum nor to nonradiative decay by the ν(Os-H) mode. For the analogous complex of Ru, there is a significant ν(Ru-H) k_H/k_D kinetic isotope effect for nonradiative decay. 37 refs., 4 figs., 4 tabs.

26323 EXAFS analysis of xanthine oxidase complexes with alloxanthine, violapterin, and 6-pteridylaldehyde. Hille, R. (Ohio State Univ., Columbus (USA)); George, G.N.; Eidsness, M.K.; Cramer, S.P. *Inorganic Chemistry (USA)*, 28(21): 4018-4022 (18 Oct 1989).

The structure of the molybdenum site of xanthine oxidase in the complexes with alloxanthine, violapterin, and 6-pteridylaldehyde has been investigated by using x-ray absorption spectroscopy. The strongest component in the EXAFS spectrum is assigned to Mo-S bonds at 2.38 ± 0.03, 2.40 ± 0.03, and 2.46 ± 0.03 Å, respectively. In all cases, a second EXAFS component was identified as corresponding to a terminal oxo group with a bond length of 1.66-1.71 Å. A terminal sulfur ligand, with a Mo=S bond length of 2.20 ± 0.03 Å, was observed for the oxidized 6-pteridylaldehyde complex. However, the presence of a short Mo=S bond ($\leq$ 2.30 Å) was ruled out for the alloxanthine and violapterin complexes. The EXAFS results are compared with previous proposals for the alloxanthine-xanthine oxidase complex. 27 refs., 4 figs., 1 tab.

26324 Synthetic and structural studies of a series of soluble cerium(IV) alkoxide and alkoxide nitrate complexes. Evans, W.J. (Univ. of California, Irvine (USA)); Deming, T.J.; Olofson, J.M.; Ziller, J.W. *Inorganic Chemistry (USA)*, 28(21): 4027-4034 (18 Oct 1989).

The reactions of $(NH_4)_2Ce(NO_3)_6$(CAN) with 2-8 equiv of $NaOCMe_3$ in THF and in tert-butyl alcohol have been studied. A series of ceric alkoxide complexes of general formula $Ce(OCMe_3)_a(NO_3)_b(solvent)_cNa_d$ (a = 1-6; b = 0-3; c = 2,4; d = 0,2; a + b = 4 + d) have been identified as well as $Ce_2(OCMe_3)_9Na$ and $Ce(OCMe_3)_{10}O$. Interconversion of these complexes by treatment with $NaOCMe_3$ or NH_4NO_3 has also been studied. The reactions of these complexes in several different solvents have been studied and are reported. The crystal structure of the complexes are also reported. 59 refs., 3 figs., 6 tabs.

26325 Crown thioether chemistry. The silver(I) complexes of trithia-9-crown-3, trithia-12-crown-3, and hexathia-18-crown-6. Blower, P.J. (Harvard Univ., Cambridge, MA (USA)); Clarkson, J.A.; Rawle, S.C.; Hartman, J.A.R.; Wolf, R.E. Jr.; Yagbasan, R.; Bott, S.G.; Cooper, S.R. *Inorganic Chemistry (USA)*, 28(21): 4040-4046 (18 Oct 1989). DOE Contract AC03-76SF00472.

The coordination chemistry of the three crown thioethers 1,4,7-trithiacyclononane (9S3), 1,5,9-trithiacyclododecane (12S3), and 1,4,7,10,13,16-hexathiacyclooctadecane (18S6) with Ag(I) has been investigated by structural and electrochemical methods. The bis complex $[Ag(9S3)_2](CF_3SO_3)$ contains a six-coordinate Ag(I) ion with Ag-S distances ranging from 2.696 (2) to 2.753 (1) Å. Chemical or electrochemical oxidation yields $[Ag(9S3)_2]^{2+}$, which has been studied by optical and EPR methods. The halide adducts [Ag(9S3)Cl] and [Ag(18S6)Br] both contain a tetrahedral AgS_3X core. In the former case, 9S3 coordinates in a tridentate fashion to yield a discrete, monomeric complex. In the latter, 18S6 provides two thioethers to one Ag(I) and a third to another to yield a polymeric chain. In $[Ag(12S3)](CF_3SO_3)$ · MeCN, each Ag(I) ion coordinates to three thioether groups (one from each of three independent 12S3 molecules) as well as a $CF_3SO_3^-$ counterion to yield distorted-tetrahedral geometry. In turn, the three ligand S atoms coordinate to different Ag(I) ions to generate a network structure. These results highlight the profound influence of ligand conformation on the structure and solution chemistry of their complexes. Crystal data for $[Ag(9S3)_2]$ (CF_3SO_3), [Ag(18S6)Br], [Ag(9S3)Cl], and $[Ag(12S3)](CF_3SO_3)$ · MeCN are reported.

26326 Structure, dynamics, and comparative stability of a mixed-ligand compound of tin(II). McGeary, M.J. (Indiana Univ., Bloomington (USA)); Folting, K.; Caulton, K.G. *Inorganic Chemistry (USA)*, 28(21): 4051-4053 (18 Oct 1989).

Attempts to produce a copper(I) stannylene complex from the combination of $Sn[N(SiMe_3)_2]_2$ with $[Cu(O^tBu)]_4$ were unsuccessful. Instead products resulting from ligand redistribution were produced. The reaction conditions and characterization studies of the reaction products are reported. 7 refs., 2 figs., 1 tab.

26327 Synthesis and structure of the zintl phase K_2SiAs_2. Hurng, W.M. (Ames Lab., IA (USA)); Peterson, E.S.; Corbett, J.D. *Inorganic Chemistry (USA)*, 28(22): 4177-4180 (1 Nov 1989). DOE Contract W-7405-ENG-82.

The remarkable instability of K_2SiAs_2, often explosive at room temperature, is reported herein. It is also noted that K_2Si (As, P)$_2$ and the binary phase Si(Se, S) are not only isosteric but also isostructural except for the potassium cations. Diminished yields from synthesis reactions run for a longer time at 450°C or at higher temperatures have strongly suggested that K_2SiAs_2 is only a kinetic intermediate on the way to KSi_3As_3 and binary phases. 19 refs., 3 figs., 2 tabs.

26328 Ferromagnetic behavior of linear-chain organometallic complexes. Structural and magnetic properties of 1:1 decamethylferrocenium salts of planar radical anion bis(dithiolato)metalates. Miller, J.S. (E.I. du Pont de Nemours and Co., Inc., Wilmington, DE (USA)); Calabrese, J.C.; Epstein, A.J. *Inorganic Chemistry (USA)*, 28(23): 4230-4238 (15 Nov 1989). DOE Contract FG02-86ER45271.

The reaction of decamethylferrocene and bis(malenonitrilethiolato)nickelate monoanion, $(Ni[S_2C_2(CN)_2]_2)^{\bullet -}$, or the platinum analogue results in the formation of purple reflecting 1:1 crystals of $[Fe(C_5Me_5)_2](MS_2C_2(CN)_2)_2$ composition. The complex $[Fe(C_5Me_5)_2](Ni[S_2C_2(CF_3)_2]_2)$ was also prepared and characterized by x-ray diffraction. These salts possess $[Fe(C_5Me_5)_2]^{\bullet +}$ cations and $[M(S_2C_2R_2)_2]^{\bullet -}$ anions with molecular structure typical of those previously characterized radical ions. The crystal structure of $[Fe(C_5Me_5)_2](Ni[S_2C_2(CN)_2]_2)$ is reported. The Pt-containing salt was found to exist in two polymorphs whose crystal structures were determined and are reported. 25 refs., 9 figs., 6 tabs.

26329 pH-dependent decomposition of β-hydroxy-substituted organophosphorus complexants. Gatrone, R.C. (Argonne National Lab., IL (USA)). *Journal of Organic Chemistry (USA)*, 54(18): 4272-4273 (1 Sep 1989). DOE Contract W-31-109-ENG-38.

Substituted ethane-1,1-diphosphonic acids containing a β-hydroxyl group undergo facile pH-dependent decomposition to phosphoric acid and acetylphosphonate. The decomposition is observed in acidic medium, while the system is stable in basic solutions.

26330 Utility of the 2,6-dimethylphenoxide ligand in providing chloride- and oxide-free $[Y(OR)_3(solvent)_a]_b$ complexes with accessible coordination sites. Brost, R.D. (Univ. of Victoria, British Columbia (Canada)); Stobart, S.R. *Inorganic Chemistry (USA)*, 28(24): 4308-4309 (29 Nov 1989).

Alkoxide complexes of yttrium have been studied as a route to the preparation of high-purity superconducting oxides such as $YBa_2Cu_3O_{7-x}$. Usually the radicals from the alkoxide are so large that an usually small (usually 3) coordination number is observed for the yttrium complex. The 2,6-dimethylphenoxide ligand reported herein was found to be able to provide halide- and oxide-free $[Y(OR)_3(solvent)_a]_b$ complexes with enough steric flexibility to achieve five- or six-coordination and to form bridged bimetallic species. The preparation and characterization of the complex are described. 21 refs., 2 figs.

26331 Oxidation photochemistry of dimolybdenum(II) diaryl phosphate promoted by visible light. Evans, W.J. (Univ. of California, Irvine (USA)); Olofson, J.M.; Ziller, J.W. *Inorganic Chemistry (USA)*, 28(24): 4309-4311 (29 Nov 1989).

The photochemical activity of the newly synthesized $Mo_2(O_2(OC_6H_5)_2)_4$ quadruply bonded metal-metal complexes with halcarbon substrates has been investigated. The two-electron photoreduction of 1,2-dichloroethane (DCE) promoted by the $^1(\delta\delta^*)$ excited state of $Mo_2(O_2P(OC_6H_5)_2)_4$ is reported herein. Electron transfer from $^1(\delta\delta^*)$ excited state of the dimolybdenum (II) diphenyl

phosphate yields the $Mo^{II}Mo^{III}Cl$ complex and $\cdot CH_2CH_2Cl$, and the reaction of the radical with another equivalent of the starting molybdenum complex directly yields the observed photoproducts. 20 refs., 2 figs.

26332 Reactions of cobalt(II) macrocycles with alkyl and alkylperoxy radicals. Bakac, A. (Ames Lab., IA (USA)); Espenson, J.H. *Inorganic Chemistry (USA),* 28(24): 4319-4322 (29 Nov 1989). DOE Contract W-7405-ENG-82.

The cobalt-carbon bond formation in the reactions of cobalt(II) macrocyles, LCo^{II} (L = C-meso-Me_6[14]aneN$_4$, Me_6[14]-4,11-dieneN$_4$, corrin, tim), with primary alkyl and substituted primary alkyl radicals takes place with rate constants in the range 10^7-10^9 M^{-1} s^{-1}. The kinetics are influenced by the nature of the macrocycle to a much greater extent than by the nature of the radicals, such that all the rate constants, k_{Co}, for a given cobalt complex fall within a factor of $\approx$ 1. For example, the values of $10^{-8}k_{Co}/M^{-1}$ s^{-1} for B_{12r} are 4.2 ($R = CH_3$), 5.1 (C_2H_5), 5.1 (CH_3OCH_2), 5.8 ($ClCH_2$), 6.1 (C_3H_7), and 9.1 ($BrCH_2$). The alkylperoxy radicals $RO_2^{\bullet}$ ($R = CH_3$, C_2H_5, $BrCH_2$) react with $Co(tim)(H_2O)_2^{2+}$ with a rate constant $k = 1.4 \times 10^8$ M^{-1} s^{-1}. 31 refs., 2 figs., 1 tab.

26333 Kinetics of reduction of a series of imidazolium ions and cobalt(III)-imidazole complexes by 1-hydroxy-1-methylethyl radicals. Bakac, A. (Iowa State Univ., Ames (USA)); Espenson, J.H.; Butkovic, V.; Lovric, J.; Orhanovic, M. *Inorganic Chemistry (USA),* 28(24): 4323-4326 (29 Nov 1989). DOE Contract W-7405-ENG-82.

The rates of electron transfer from $^{\bullet}C(CH_3)_2OH$ to a series of imidazolium ions and to a series of $(NH_3)_5Co(X\text{-}Im)^{3+}$ complexes have been measured. A kinetic competition method based on the homolytic scission of the chromium-carbon bond in $(H_2O)_5CrC(CH_3)_2OH^{2+}$ was used to evaluate rate constants for the reducing agent $^{\bullet}C(CH_3)_2OH$. In both series the rate constants show sensitivity to substituents on the imidazole ring. The rate constants for the free imidazolium ions are correlated by an LFER to the relative electron affinity of the imidazolium ion. The rate constants for the cobalt(III)-imidazole complexes are correlated by the lowest energy d-d absorption band of the complexes. 15 refs., 4 figs., 5 tabs.

26334 Synthesis of acyclic sugar aldehydes by ozonolysis of oximes. Weitz, D.J. (Lawrence Berkeley Labs., CA (USA)); Bednarski, M.D. *Journal of Organic Chemistry (USA),* 54(20): 4957-4959 (29 Sep 1989). DOE Contract AC03-76SF00098.

This note reports on an efficient method for the synthesis of acyclic sugar aldehydes based on the ozonolysis of methyloxime-protected aldoses. Readily accessible protected sugar oximes are converted into the corresponding aldehydro sugars in good yield and high purity on a multigram scale. This methodology eliminates problems associated with decomposition of these aldehydes by β-elimination and the formation of side products that contaminate the aldehyde after deprotection.

26335 Tandem mass spectrometry of highly charged cytochrome c molecular ions produced by electrospray ionization. Smith, R.D. (Pacific Northwest Lab., Richland, WA (USA)); Barinaga, C.J.; Udseth, H.R. *Journal of Physical Chemistry (USA),* 93(13): 5019-5022 (29 Jun 1989). DOE Contract AC06-76RL01830.

The dissociation of multiply charged molecular ions of cytochrome c (MW 12,360 daltons) formed by electrospray ionization (ESI) has been studied by use of tandem (triple quadrupole) mass spectrometry. For the selected experimental conditions both metastable and collision-induced-dissociation (CID) processes are observed for the 14+ to 19+ protonated molecular ions, while lower charge state spectra (9+ to 12+) are dominated by charge-transfer and charge-stripping processes. For higher charge states two classes of dissociation processes are evident. The first involves dissociation (both metastable and CID) from higher internal energy (and apparently thermalized) molecular ions and yields distinctive fragments in the m/z region about the molecular ion. The second occurs for higher collision energies and yields a very large number of low intensity products across a wide m/z range. The collisional excitation gained in the ESI/vacuum interface and the slow dissociation rates anticipated for large molecular ions appear important to these observations.

26336 Ab initio reaction paths and direct dynamics calculations. Baldridge, K.K. (North Dakota State Univ., Fargo (USA)); Gordon, M.S.; Steckler, R.; Truhlar, D.G. *Journal of Physical Chemistry (USA),* 93(13): 5107-5119 (29 Jun 1989). DOE Contract FG02-86ER13579.

A detailed study of methods for generating the minimum energy path of a chemical reaction using ab initio electronic structure calculations is presented; the convergence with respect to step size of the geometry and energy along this path is studied with several algorithms. The investigations are extended to the calculation of chemical reaction rate coefficients by interfacing the polyrate code for variational transition-state theory and semiclassical tunneling calculations with a locally modified Gaussian 82 electronic structure package that now contains reaction path following capabilities at both the Hartree-Fock and perturbation theory levels. This combined package is used to study the kinetics of the abstraction reaction $CH_3 + H_2 \rightarrow CH_4 + H$, which is considered as a prototype organic reaction. They report calculations of reaction rates based on electronic structure theory and generalized transition-state theory, including a multidimensional tunneling correction, without performing an analytic fit to the potential surface. The calculation of dynamical processes directly from ab initio electronic structure input without the intermediary of a potential surface fit is called direct dynamics, and this paper demonstrates the feasibility of this approach for bimolecular reactions.

26337 Decarbonylation of unprotected aldose sugars by chlorotris(triphenylphosphine)rhodium(I). A new descent of series approach to alditols, deoxyalditols, and glycosylalditols. Andrews, M.A. (Brookhaven National Lab., Upton, NY (USA)); Gould, G.L.; Klaeren, S.A. *Journal of Organic Chemistry (USA),* 54(22): 5257-5264 (27 Oct 1989). DOE Contract AC02-76CH00016.

Unprotected C_n aldose sugars are cleanly decarbonylated by 1 equiv of chlorotris(triphenylphosphine)rhodium(I) in 1-24 h at 130°C in N-methyl-2-pyrrolidinone solution to give the corresponding C_{n-1} alditol in about 75-95% yields. This technique represents a useful variation on traditional carbohydrate descent of series reactions. The procedure is quite general and also works on a number of aldose derivatives, such as deoxy sugars, N-acetylated amino sugars, and disaccharides, providing convenient small-scale syntheses of deoxyalditols, (acetylamino)-deoxyalditols, and glycosylalditols, respectively. The reactions proceed with complete retention of stereochemistry, the only side products observed being a few percent of the C_n lactones and the C_{n-2} alditol. Attempts to make the reactions catalytic have not yet been very successful.

26338 Infrared spectroscopy of the pentacoordinated carbonium ion $C_2H_7^+$. Yeh, L.I. (Lawrence Berkeley Lab., CA (USA)); Price, J.M.; Lee, Y.T. *Journal of the American Chemical Society (USA),* 111(15): 5597-5604 (19 Jul 1989). DOE Contract AC03-76SF00098.

The infrared spectrum of $C_2H_7^+$ has been obtained from 2,500 to 4,200 cm^{-1}. The apparatus consists of a tandem mass spectrometer with a radio-frequency octopole ion trap. After initial mass selection of the $C_2H_7^+$ in a sector magnet, the $C_2H_7^+$ is spectroscopically probed by using a two-color laser scheme while being trapped under ultrahigh-vacuum conditions. The first laser is scanned from 2,500 to 4,200 cm^{-1} and excites a C-H stretching vibration. The second laser is a continuous-wave CO_2 laser and is used to dissociate the vibrationally excited parent ions through a multiphoton process. The fragment ion $C_2H_5^+$ is detected by using a quadrupole mass spectrometer. Two sets of spectral features were studied that showed different dependences on the backing pressure in the ion source, on the mixing ratio of hydrogen to ethane, and on the presence or absence of the second laser. Arguments are presented that the two groups of bands can be assigned to the classical and bridging structures of $C_2H_7^+$.

26339 Electron exchange between potassium bis(tert-butyl[8]annulene)ytterbate(II) and potassium bis(tert-butyl[8]annulene)ytterbate(III). Eisenberg, D.C. (Lawrence Berkeley Lab., CA (USA)); Kinsley, S.A.; Streitwieser, A. *Journal of the American Chemical Society (USA),* 111(15): 5769-5772 (19 Jul 1989). DOE Contract AC03-76SF00098.

Exchange on the ^1H NMR time scale has been observed between potassium bis([8]annulene)ytterbate(II) (1) and potassium bis([8]annulene)ytterbate(III) (2). The absence of exchange between potassium bis([8]annulene)calcate(II) and 2 demonstrates that the measured exchange is electron exchange rather than ligand exchange. Rates of exchange have been determined between the corresponding tert-butyl derivatives, potassium bis(tert-butyl[8]annulene)ytterbate(II) (3) and potassium bis(tert-butyl[8]annulene)ytterbate(III) (4), by NMR line broadening techniques; typical second-order rate constants are 5×10^7 M^{-1} s^{-1} at 19.3°C in tetrahydrofuran (THF) and 1×10^7 M^{-1} s^{-1} in THF containing diglyme. From these results and the activation parameters a mechanism is proposed that involves change in coordination of solvating diglyme.

26340 Sodium perborate: A mild and convenient reagent for efficiently oxidizing organoboranes. Kabalka, G.W. (Univ. of Tennessee, Knoxville (USA)); Shoup, T.M.; Goudgaon, N.M. *Journal of Organic Chemistry (USA)*, 54(25): 5930-5933 (8 Dec 1989). DOE Contract FG05-86ER60434.

Sodium perborate, a readily available and inexpensive reagent, efficiently oxidizes organoboranes. The reagent permits the oxidation of a wide variety of functionally substituted organoboranes. In nearly every instance, the product yields exceed those obtained using standard oxidation procedures.

26341 ^{13} NMR spectroscopy of α,ω-diphenylpolyenyl anions. Confirmation of charge localization in soliton model compounds. Tolbert, L.M. (Georgia Institute of Technology, Atlanta (USA)); Ogle, M.E. *Journal of the American Chemical Society (USA)*, 111(15): 5958-5959 (19 Jul 1989). DOE Contract FG05-85ER45194.

The notion that delocalization in ostensibly infinite polyacetylene chains treated with π-donors or acceptors only extends over a limited domain has been one of the more controversial aspects of the soliton theory. According to this theory, electrical conductivity in such systems is due to the presence of mobile charged defects (solitons) which are described in terms appropriate for a resonance-delocalized carbanion with a conjugation length of approximately 31 CH units or, more precisely, a full width at half height of 15 CH units. Phenyl-terminated anions were chosen for their stability and ease of preparation as well as for their utility for estimating delocalization; that is, at what point does negative charge cease to delocalize into the aromatic rings? The Dewar nonbonded molecular orbital (NBMO) formalism predicts, at the Hueckel level, even distribution of negative charge at the odd-numbered carbon atoms and zero charge (nodes) at the even carbons. In contrast, the SSH theory, a modified Hueckel treatment reminiscent of the ω bond-order approach, predicts accumulation of charge at the central carbon atoms, again with nodes at even carbons. Less intuitively, the Boudreaux, Chance, Bredas, Silbey (BCBS) modification of the soliton theory, based upon an MNDO method, predicts charge alteration, with even atoms possessing positive charge as a result of charge polarization by the negatively charged odd centers. They have been able to resolve this issue by an appeal to the Spiesecke-Schneider correlation of charge density with ^{13}C chemical shift.

26342 Controlling factors in deoxygenation kinetics and selectivity: Reactions of ethylene oxide on Mo(110). Serafin, J.G. (Harvard Univ., Cambridge, MA (USA)); Friend, C.M. *Journal of the American Chemical Society (USA)*, 111(16): 6019-6026 (2 Aug 1989). DOE Contract FG02-84ER13289.

Ethylene oxide intramolecularly eliminates ethylene directly into the gas phase at 200 K ($E_a \sim 12$ kcal/mol) during reaction on Mo(110) with 70% efficiency as shown by temperature-programmed reaction and x-ray photoelectron spectroscopy. Atomic oxygen, a product of this reaction, increases the rate of ethylene formation by slowing the kinetics for the competing nonselective decomposition pathway which accounts for the other 30% of reaction of chemisorbed ethylene oxide. The nonselective decomposition products of reaction are gaseous dihydrogen, surface carbon, and oxygen. At high ethylene oxide exposures, a small amount of molecular desorption is also observed at 150 K. Deposition of an atomic oxygen overlayer ($\theta_0 \sim 0.27$) on Mo(110) prior to reaction enhances the selectivity of the ethylene formation reaction to 90%. Reaction saturation is controlled by the buildup of hydrocarbon fragments on clean Mo(110) and by oxygen site blocking on the oxygen precovered surface as shown by isothermal reaction spectroscopy. Carbon-heteroatom bond strength correlates with the temperature of ethylene formation in comparing reaction of ethylene oxide to that of the sulfur-containing analogue, ethylene sulfide, on Mo(110).

26343 Multiphoton ionization of acetone clusters: Metastable unimolecular decomposition of acetone cluster ions and the influence of solvation on intracluster ion-molecule reactions. Tzeng, W.B. (Pennsylvania State Univ., University Park (USA)); Wei, S.; Castleman, A.W. Jr. *Journal of the American Chemical Society (USA)*, 111(16): 6035-6040 (2 Aug 1989). DOE Contract FG02-88ER60648.

A comprehensive investigation of the reactions of acetone ions in clusters was made to investigate and compare the similarities and differences in the ion reactions due to solvation effects. Neutral acetone clusters, prepared in a pulsed nozzle supersonic expansion, are ionized using multiphoton ionization and investigated using a time-of-flight reflectron technique. The observed major cluster ions resulting from prompt fragmentation following ionization are $[(CH_3)_2CO]_m \times H^+$ (m = 1-15), $[(CH_3)_2CO]_m \times C_2H_3O^+$ (m = 1-17), and $[(CH_3)_2CO]_m \times CH_3^+$ (m = 1-10). In a time window of a few tens of microseconds, all three classes of cluster ions unimolecularly decompose, losing only one acetone monomer. Interestingly, a reaction corresponding to the dehydration of $[(CH_3)_2CO]_m \times H^+$ and leading to the production of $[(CH_3)_2CO]_{m-2} \times C_6H_{11}O^+$ is observed for m = 2-6. The most striking finding of the present study is that the presence of water molecules in a cluster suppresses the dehydration reaction. This finding clarifies the discrepancy between earlier studies reported in the literature and, most importantly, provides further evidence for the influence of a solvent on ion reactions in clusters, and ion-molecule reactions in general.

26344 Time-resolved Raman detection of v(Fe-O) in an early intermediate in the reduction of O_2 by cytochrome oxidase. Varotsis, C. (Michigan State Univ., East Lansing (USA)); Babcock, G.T.; Woodruff, W.H. *Journal of the American Chemical Society (USA)*, 111(16): 6439-6440 (2 Aug 1989).

Cytochrome oxidase contains four redox-active centers per functional unit. These reducing equivalents are transferred to the binuclear cyt $a_3 \cdots Cu_B$ center, which binds O_2 and reduces it to H_2O. Although the reaction between O_2 and cytochrome oxidase occurs too quickly to be studied by conventional stopped-flow techniques, Gibson and Greenwood showed that photolysis of the cytochrome a_3^{2+}-CO complex of the enzyme in the presence of O_2 could be used to circumvent this limitation. The authors have developed techniques that allow them to carry out low-frequency Raman detection under flow/flash conditions; here they report $v(Fe^{2+}\text{-}O)$ for an early intermediate in the cytochrome oxidase/dioxygen reaction.

4004 Electrochemistry

Refer also to citation(s) 25752, 25848, 25850, 26073, 26075, 26242, 26244, 26360, 26540

26345 (Juel-Conf-77, pp. 447-454) **Electrochemical deposition of titanium from nonaqueous media.** Koneska, Z. (Skopje Univ. (Yugoslavia). Tehnolosko-Metalurski Fakultet); Popov, B.; Jovanovski, G. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325--: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01.

This paper studies the electrochemical reduction of TiJ_4 in dimethylformamide (DMF) and $TiCl_3$ in dimethylsulfoxide (DMSO). (MM).

26346 Driving-force effects on the rate of long-range electron transfer in ruthenium-modified cytochrome C. Meade, T.J. (Arthur Amos Noyes Lab., Pasadena, CA (USA)); Gray, H.B.; Winkler, J.R. *Journal of the American Chemical Society (USA)*,

111(12): 4353-4356 (7 Jun 1989). DOE Contract AC02-76CH00016.

Two new Ru-modified, Zn-substituted derivatives of horse heart cytochrome c have been prepared, Rua_4L(histidine-33)-Zn-cyt c (a = NH_3; L = pyridine, isonicotinamide). Molecular mechanics modeling indicates that the 11.7 Å edge-to-edge separation between the redox centers is virtually identical with that reported for the Ru-pentaammine derivative. Rates of photoinduced charge separation and recombination in Rua_4L (His-33)-Zn-cyt c lie in the range of 2.0×10^5-3.3×10^6 s^{-1} (22°C). These kinetics, along with those already reported, provide a total of eight intramolecular electron-transfer reactions that have been measured in Ru-M-cyt c (M = Fe, Zn) at driving forces ($-\Delta G°$) ranging from 0.18 to 1.05 eV. The variation of the rate with driving force is in general agreement with the semiclassical theory of electron-transfer reactions. Fitting the Ru-Zn-cyt c charge-separation data yields a reorganization energy (λ) of 1.15 (5) eV and an electronic coupling matrix element (H_{AB}) of 0.13 (1) cm^{-1}. The charge-recombination data are fit with the parameters λ = 1.24 (5) eV and H_{AB} = 0.10 (1) cm^{-1}, and the Ru-Fe cyt c electron-transfer rate can be described with λ = 1.2 eV and H_{AB} = 0.03 cm^{-1}.

4005 Photochemistry

Refer also to citation(s) 26122, 26157, 26210, 26246, 26247, 26248, 26255, 26256, 26257, 26266, 26269, 26317, 26322, 26331, 26343, 26540

26347 (AFME–82-066-9) **PIRSEM operations review 1982-1985. Photochemistry.** Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France); Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM). 1987. 220p. (In French). (AFME–85-91-1002-9). Order Number DE90770657. Available from NTIS (US Sales Only), PC A10/MF A01.

Extracts and budgets from the annual reports (1982, 1983, 1984, 1985) of the PIRSEM concerning photochemistry research programs are presented in this review. Some of the themes studied or sponsorized are photochemical conversion of solar energy, organic or organic-metallic compounds for photovoltaic effects, photolysis of water, colouring semiconductor interface, photoassisted synthesis of NH3, study of the transport phenomena at the electrode-sensitizer-electrolyte interface, etc.

26348 (ENEA-RT-TIB–89-14) **High resolution infrared spectrum and analysis of the nu_2 band of CF_3I.** Fantoni, R.; Snels, M. ENEA, Frascati (Italy). Centro Ricerche Energia. Jun 1989. 17p. (RT/TIB–89-14). Order Number DE90764315. Available from NTIS (US Sales Only), PC A03/MF A01.

Submitted to Molecular Physics.

The vibro-rotational spectrum of CF3I has been recorded in the 13.5 micron (733-752 cm^{minus1}) region using a tunable diode laser spectrometer. The K-structure of $thenu_2$ fundamental vibration could be resolved for a series of P(J) and R(J) multiplets, from P(61) up toR(70). Furthermore, many P(J) and R(J) multiplets were assigned to the hot-bands nu_2 plus nu_6 minus nu_6 and nu_2 plus nu_3 minus nu_3. Accurate molecular constants were determined from a least squares fit of the observed transition frequencies. In particular, band origins of 743.3680 cm_{minus1}, 742.6177 cm_{minus1} and 741.9132 cm_{minus1} were established for the nu_2, nu_2 plus nu_6 minus nu_6 and nu_2 plus nu_3 minus nu_3 bands, respectively.

26349 (LBL–28512) **Matrix photochemistry of small molecules: Influencing reaction dynamics on electronically excited hypersurfaces.** Laursen, S.L. Lawrence Berkeley Lab., CA (USA). Jan 1990. 170p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC03-76SF00098. (LBL–28524). Order Number DE90009067. Available from NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.

Investigations of chemical reactions on electronically excited reaction surfaces are presented. The role of excited-surface multiplicity is of particular interest, as are chemical reactivity and energy transfer in systems in which photochemistry is initiated through a metal atom "sensitizer." Two approaches are employed: A heavy-atom matrix affords access to forbidden triplet reaction surfaces, eliminating the need for a potentially reactive sensitizer. Later, the role of the metal atom in the photosensitization process is examined directly.

26350 Chemical approaches to artificial photosynthesis. Meyer, T.J. (Univ. of North Carolina, Chapel Hill (USA)). *Accounts of Chemical Research (USA)*, 22(5): 163-170 (May 1989). DOE Contract FG05-86ER13633.

In artificial photosynthesis, the goal is to mimic the ability of green plants and other photosynthetic organisms in their use of sunlight to make high-energy chemicals. This is a difficult problem chemically, which accounts for much of the complexity of the natural photosynthetic apparatus. Nonetheless, a number of promising approaches have appeared in recent years based on semiconductors, membranes, vesicles, and molecular systems. In this Account the author will describe some of the approaches that my own group has taken to the design of chemical systems for artificial photosynthesis.

26351 Intermediates in the charge-transfer and ligand-labilization photoreactions of molybdenum(V) μ-oxo dimers. Feliz, M. (Univ. of Notre Dame, IN (USA)); Ferraudi, G. *Inorganic Chemistry (USA)*, 28(24): 4422-4425 (29 Nov 1989).

The photochemistry of Mo(V) complexes has been investigated in a flash photolysis and pulse radiolysis study of $Mo_2O_4(OH_2)_6^{2+}$ and $Mo_2O_4Cl_6^{4-}$. Transient spectra recorded in near uv-flash photolysis of the two compounds in aqueous solutions were found to reflect the formation of species related to the photoinduced opening of one μ-oxo bridge and a photoreduction of the complex to $Mo^{IV}Mo^{V}$ dimers. The dual photoreactivity, ligand photooxidation, and ligand photolabilization exhibited by these Mo(V) dimers were thought to be a consequence of the different excited states that are populated by irradiation in the uv region. Charge-transfer transitions are thought to account for intense absorptions in the spectra of the Mo(V) dimers that were observed at wavelengths shorter than 250nm. 23 refs., 4 figs.

26352 Temperature and solvent-polarity dependence of the absorption and fluorescence spectra of a fixed-distance symmetric chlorophyll dimer. Johnson, S.G. (Iowa State Univ., Ames (USA)); Small, G.J.; Johnson, D.G.; Svec, W.A.; Wasielewski, M.R. *Journal of Physical Chemistry (USA)*, 93(14): 5437-5444 (13 Jul 1989). DOE Contract W-7405-ENG-82;W-31109-ENG-38.

Temperature-dependent absorption and fluorescence spectra and line-narrowed fluorescence and excitation spectra are reported for a dimer consisting of two methylpyrochlorophyllide a molecules that share a vinyl group at the 2-position of each macrocycle. The data (obtained for three solvents of widely differing polarity) show that the dimer exists in two conformations (A and B) and that excited-state relaxation from A to B onsets near the glass transition temperature (T_g). Molecular modeling suggests that the two conformations are related by bicycling of the two single bonds joined to the vinyl group linkage. At sufficiently low temperature, the solvent dynamics are rate limiting for the conformational relaxation. For a solvent of sufficiently high polarity (DMF), the excited state of B is shown to access a new radiationless decay channel for $T \geq T_g$. A charge-transfer state is suggested to be important for this decay. The model presented is shown to provide a qualitative explanation for the frequency domain and recently obtained picosecond and fluorescence quantum yield room-temperature data.

26353 Structure and marker mode of the primary electron donor state absorption of photosynthetic bacteria: Hole-burned spectra. Johnson, S.G. (Iowa State Univ., Ames (USA)); Tang, D.; Jankowiak, R.; Hayes, J.M.; Small, G.J.; Tiede, D.M. *Journal of Physical Chemistry (USA)*, 93(16): 5953-5957 (10 Aug 1989). DOE Contract W-31109-ENG-38;W-7405-ENG-82.

Structured photochemical hole-burned spectra are presented for P870 and P960 of the reaction centers (RC) of Rhodobacter sphaeroides and Rhodopseudomonas viridis. A special pair marker mode Franck-Condon progression is identified. The zero-phonon holes yield P870* and P960* decay times in good agreement with the time domain values. Site excitation energy selection is used to

establish correlation between a higher energy RC state of Rps. viridis and P960*.

26354 Photoionization of alkylmethylviologens in vesicles: Effects to the alkyl chain length in alkylmethylviologen and radical conversion to surfactant radicals. Sakaguchi, Masato (Univ. of Houston, TX (USA)); Kevan, L. *Journal of Physical Chemistry (USA)*, 93(16): 6039-6043 (10 Aug 1989).

Electron spin resonance spectroscopy has been applied to observe the photoionization yields of alkylmethylviologen (AV^{2+}) in rapidly frozen dipalmitoylphosphatidylcholine (DPPC), dioctadecyldimethylammonium chloride (DODAC), and dihexadecyl phosphate (DHP) vesicles. A singlet spectrum (g = 2.0030) due to the alkylmethylviologen cation radical (AV^{+}) was observed from AV^{2+} in each frozen vesicle system irradiated for 10 min with wavelength $240 < \lambda < 410$ nm. An alkyl radical from DODAC (DAC) was observed from AV^{2+} in DODAC irradiated for 200 min and was assigned as $CH_3CHCH_2(CH_2)_{15}N\text{-}(CH_3)_2C_{18}H_{37}$. DAC was produced by radical conversion from AV^{+} during photoirradiation with wavelength $240 < \lambda < 300$ nm. The photoionization yields were enhanced by a longer alkyl chain of AV^{2+}. Electron spin echo modulation spectroscopy data support a correlation between the alkyl chain length and the photoionization yield. The highest photoionization yield was obtained in hexadecylmethylalkylviologen in DODAC which has the longest of alkyl chain length. The highest photoionization yield is assisted by radical conversion from AV^{+} to DAC which impedes a back-reaction from AV^{+} to AV^{2+}.

26355 One-electron reduction of tris(2,2′-bipyrimidine)ruthenium(2+) ion in aqueous solution. A photochemical, radiation chemical, and electrochemical study. Neshvad, G. (Boston Univ., MA (USA)); Hoffman, M.Z.; Mulazzani, Q.G.; Ciano, M.; D'Angelantonio, M.; Venturi, M. *Journal of Physical Chemistry (USA)*, 93(16): 6080-6088 (10 Aug 1989).

The reduction of $Ru(bpm)_3^{2+}$ in aqueous solution has been investigated by use of photochemical, radiation chemical, and electrochemical techniques. The luminescent excited state of the substrate, $^*Ru(bpm)_3^{2+}$, has a lifetime (τ_0) of 0.081 μs and a standard reduction potential of $\sim$ 1.2 V; it is quenched by electron donors (D) such as ethylenediaminetetraacetic acid (EDTA), triethanolamine (TEOA), ascorbate ion, deprotonated cysteine, and reduced glutathione with values of k_q that depend on the pH of the solution and the reducing ability of the quencher. The one-electron-reduced species, $Ru(bpm)_3^{+}$, is formed in the quenching reaction; it is also produced electrochemically and from the reaction of radiolytically generated $CO_2^{\cdot-}$ with $Ru(bpm)_3^{2+}$ ($k = 6.7 \times 10^9$ M^{-1} s^{-1}). $Ru(bpm)_3^{+}$ is a good reducing agent ($E_{ox}^0 = 0.73$ V) and reduces MV^{2+} (methylviologen) to $MV^{\cdot+}$ ($k = 1.0 \times 10^9$ M^{-1} s^{-1}). $Ru(bpm)_3^{+}$ also undergoes protonation; its acidic form (pK_a 6.3) is a milder reducing agent ($E_{ox}^0 = 0.50$ V) but is still capable of reducing MV^{2+} ($k = 1.0 \times 10^6$ M^{-1} s^{-1}). Both forms of $Ru(bpm)_3^{+}$ are unstable with respect to long-term storage; it is likely they engage in disproportionation and/or reaction with the solvent. The continuous photolysis of a solution containing $Ru(bpm)_3^{2+}$, MV^{2+}, and a sacrificial reductive quencher (EDTA, TEOA) generates $MV^{\cdot+}$. Values of η_{ce} of 0.64 and $\sim$0.7 for TEOA and EDTA, respectively, in alkaline solution have been obtained.

26356 A study of the photoionization of anion radicals in aqueous solution. Natarajan, P. (Univ. of Notre Dame, IN (USA)); Fessenden, R.W. *Journal of Physical Chemistry (USA)*, 93(16): 6095-6100 (10 Aug 1989).

The photolysis of a number of radical anions of substituted aromatic carboxylic acids has been investigated by two-pulse experiments using pulse radiolysis and laser photolysis. The aim of the study is to determine the photophysical and photochemical processes that follow optical excitation of these radicals. Photoionization with varying quantum efficiencies from 0.4 for benzoate dianion radical to <0.01 for anion radicals of formyl-, acetyl-, and benzoylbenzoic acids is found to be the only process in all but a few special cases. In no case was luminescence of the radical observed. The quantum yields seem to be strongly affected by structural factors even when the energetics are favorable. Because the radicals selected for study absorb in the visible region, it has thus been possible to examine the process of charge separation with photons of a much lower energy than is necessary for most normal molecules. It is hoped these results may provide insights that will be of value in the design of systems to provide useful conversion of solar energy.

26357 Mechanism of porphyrin reduction and decomposition in a high-pressure chemical ionization plasma. Van Berkel, G.J. (Oak Ridge National Lab., TN (USA)); Glish, G.L.; McLuckey, S.A.; Tuinman, A.A. *Journal of the American Chemical Society (USA)*, 111(16): 6027-6035 (2 Aug 1989). DOE Contract AC05-84OR21400.

Mechanisms for the in situ reduction and decomposition of porphyrins that occur in a high-pressure ammonia and hydrogen chemical ionization (CI) plasma are proposed based on studies of selected model porphyrins and porphyrinogens, both in a high-pressure CI ion source and under low-pressure CI conditions in a three-dimensional quadrupole ion trap. Stepwise reduction of the porphyrin by radical hydrogen, aided by interaction of the porphyrin with the interior surfaces of the ion source, followed by ionization, forms molecular species, $(M + nH)^+$, where n = 0, 2, 4, and 6 when using hydrogen, and where n = 1,3,5, and 7 when using ammonia. The major fragment ions in the CI mass spectra, although arising from the reduced molecular species, are not products of simple unimolecular dissociation of the $(M + nH)^+$ species. Mass spectrometry/mass spectrometry (MS/MS) studies show that the $(M + nH)^+$ species, where n { >=} 2, fragment to form tri-, di-, and monopyrrolic units with masses two or more mass units less than the most abundant pyrrolic fragment ions observed in the CI mass spectra. Therefore, gas-phase unimolecular decomposition of the reduced ionic species can contribute somewhat to the overall CI mass spectrum. However, the major pyrrolic fragment ions observed in these spectra (as well as the majority of the other fragments) more likely result from unimolecular and thermal decomposition of the reduced species (both ionic and neutral) in the gas-phase and on the source surfaces, forming neutrals that possibly undergo additional reactions in the CI plasma prior to ionization.

26358 Metalloporphyrin-sensitized photooxidation of water to oxygen on the surface of colloidal iridium oxides. Photochemical and pulse radiolytic studies. Nahor, G.S. (National Institute of Standards and Technology, Gaithersburg, MD (USA)); Neta, P.; Hambright, P.; Thompson, A.N. Jr.; Harriman, A. *Journal of Physical Chemistry (USA)*, 93(16): 6181-6187 (10 Aug 1989).

Derivatives of TSPP (tetrakis(4-sulfonatophenyl)porphyrin) were prepared and tested as photosensitizers for oxidation of water to oxygen on the surface of colloidal iridium oxide. Triplet quantum yields, energies, and lifetimes were measured by laser flash photolysis. Rate constants for quenching the porphyrin triplet state with O_2 and with persulfate ions were also determined. The rates of interaction between the porphyrin radical cations and colloidal IrO_x particles were measured by pulse radiolysis for several of the compounds. The one-electron oxidation potentials of the porphyrins, measured by cyclic voltammetry, were varied between 0.7 and 1.4 V vs. NHE by using different metal centers and by substitution on the phenyl rings. Illumination of a porphyrin in the presence of sodium persulfate and an IrO_x colloid resulted in generation of O_2 in a process that was strongly dependent upon pH and upon the nature of the photosensitizer in the same manner as the kinetics determined by pulse radiolysis. The rate of O_2 production under any conditions could be explained on the basis of thermodynamic criteria relating to either of the individual quenching or water oxidation steps. Zn porphyrins ($0.9 < E_{\frac{1}{2}} < 1.02$ V) effected O_2 production only in alkaline solution, whereas PdTSPP ($E_{\frac{1}{2}} = 1.1$ V) gave efficient O_2 evolution even in neutral solution. Further increase in $E_{1/2}$, as achieved with InTSPP ($E_{\frac{1}{2}} = 1.16$ V), lowers the threshold pH for O_2 evolution, and pulse radiolysis experiments confirmed that the radical cation of this porphyrin is the most reactive toward the catalyst, reacting at diffusion-controlled rates even in acidic solutions. However, the rate of O_2 formation with InTSPP was very low due to the inefficient photochemistry arising from the incomplete quenching of this less-reducing porphyrin triplet state by persulfate ions.

26359 The effect of phenyl ring torsional rigidity on the photophysical behavior of tetraphenylethylenes. Shultz, D.A.

(Univ. of Texas, Austin (USA)); Fox, M.A. *Journal of the American Chemical Society (USA)*, 111(16): 6311-6320 (2 Aug 1989).

The synthesis and photochemical behavior of several members of the bis[n.1]metacyclophanylidene series are presented. The properties of these compounds are compared to a model compound, tetra-3-tolylethylene. The photophysical properties of the tethered tetraphenylethylenes change dramatically with the length of hydrocarbon tethers connecting the gem-phenyl rings. From these changes in photophysical properties and analysis of ground-water structures and properties, they propose that phenyl ring torsional motion plays a significant, if not primary, role in the photochemical of tetraphenylethylenes.

26360 Photoelectrochemistry of strained-layer and lattice-matched superlattice electrodes: Effects due to buffer layers. Nozik, A.J. (Solar Energy Research Institute, Golden, CO (USA)); Thacker, B.R.; Turner, J.A.; Peterson, M.W. *Journal of the American Chemical Society (USA)*, 110(23): 7630-7637 (9 Nov 1988).

Strained-layer and lattice-matched superlattice electrodes have been studied and compared as photoelectrodes in photoelectrochemical cells, and the effects of the presence of buffer layers in the strained-layer systems have been established. Photocurrent spectroscopy and photomodulated reflectance spectroscopy of superlattice electrodes, etched superlattice electrodes, and buffer layer structures reveal that highly strained superlattices (1.8% mismatch) have poorly defined quantization effects in their quantum wells; strained-layer superlattices with less mismatch (0.9%) have better defined quantization, but this is not reflected in their photocurrent spectra. On the other hand, lattice-matched superlattice electrodes exhibit extremely well-defined quantization effects that are clearly exhibited in multiple photocurrent peaks that match theoretical predictions; photomodulated reflectance spectra exhibit 17 transitions that represent all the possible allowed transitions in the quantum wells, including all light and heavy hole transitions, as well as unconfined transitions above the well barriers. The present work indicates that previous results reported for the photoelectrochemistry of highly strained superlattices probably reflected a photoresponse that was influenced more by the buffer layers than by the superlattice layers. The occurrence of hot electron transfer from photoexcited superlattice electrodes remains to be demonstrated unequivocally.

26361 The orientation of CO in carbonmonoxy cytochrome oxidase and its transient photoproducts. Direct evidence from time-resolved infrared linear dichroism. Dyer, R.B. (Los Alamos National Lab., NM (USA)); Lopez-Garriga, J.J.; Einarsdottir, O.; Woodruff, W.H. *Journal of the American Chemical Society (USA)*, 111(24): 8962-8963 (22 Nov 1989).

Cytochrome oxidase (cytochrome aa_3 or CcO) mediates the facile reduction of O_2 by cytochrome c in all plants and animals and numerous lower organisms and conserves the energy of this reaction as a transmembrane proton gradient. The crucial early steps in the activation of O_2 involve its binding to the heme/copper site, denoted cytochrome a_3/copper B. The coordination chemistry and structure of this site are essential, but poorly understood, functional features of the enzyme. In this report they have applied time-resolved infrared linear dichroism (TRIRLID) to the CO complex of fully reduced CcO from bovine heart and have measured directly the orientation of the C-O bond axis with respect to the heme normal of cytochrome a_3, both in Fe_{a3}^{2+}-CO and in the Cu_B^+-CO phototransient.

4006 Radiation Chemistry

Refer also to citation(s) 25621, 26267, 26351

26362 Stochastic models of diffusion-controlled ionic reactions in radiation-induced spurs. 2. Low-permittivity solvents. Green, N.J.B. (Physical Chemistry Lab., Oxford (England)); Pilling, M.J.; Pimblott, S.M.; Clifford, P. *Journal of Physical Chemistry (USA)*, 93(24): 8025-8031 (30 Nov 1989).

The diffusion-controlled recombination of small clusters of ions in low-permittivity solvents is considered. A Monte Carlo simulation technique used previously for high-permittivity solvents is introduced and discussed briefly. The independent reaction times (IRT) simulation method is described, and its implementation for the kinetics of ion clusters is detailed. The IRT approximation is tested against the full Monte Carlo simulation for a variety of random and nonrandom initial configurations and against alternative analytic theories. We find the IRT method to be surprisingly accurate under these stringent conditions.

4007 Radiochemistry and Nuclear Chemistry

Refer also to citation(s) 26362, 27098, 27099, 27100, 27101, 27102, 27103, 27104, 27105, 27106, 27107, 27108, 27109, 27110, 27111, 27112, 27113, 27114, 27115, 27116, 27117, 27118, 27119, 27120, 27121, 27122, 27123, 27124, 27125, 27126, 27127, 27128, 27129, 27130, 27131, 27132, 27133, 27134, 27135, 27136, 27137, 27138, 27139, 27140, 27141, 27142, 27143, 27144, 27145, 27146, 27147, 27148, 27149, 27150, 27151, 27152, 27153, 27154, 27155, 27156, 27157, 27158, 27159, 27160, 27161, 27162, 27163, 27164, 27165, 27166, 27167, 27168, 27169, 27170, 27171, 27172, 27173, 27174, 27175, 27176, 27177, 27178, 27179, 27180, 27181, 27182, 27183, 27185, 27186, 27205

26363 (CIEMAT–624) **Calibration of uranium 232 solution.** Galan, M.P.; Acena, M.L. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas, Madrid (Spain). 1988. 19p. (In Spanish). Order Number DE90622782. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A method for acertainning the activity by alpha spectroscopy with semiconductor detectors, of a solution of Uranium-232 is presented. It consists of the comparison with a Uranium-233 solution activity previously measured in a gridded ionization chamber of 2 π geometry. The total measurement uncertainty is about +- 0,02. (Author).

26364 (KAERI/RR–716/88) **Study of ion separation through solid-supported liquid membrane.** Kang, Young Ho (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Lee, Kang Ill; Kwon, Sun Il; Kim, Jung Do; Kim, Kyoung Ho. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 84p. (In Korean). Order Number DE90622780. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

In this study, a theory was developed and validated for predicting the uranium flux through the solid-supported liquid membrane as a function of PH on the feed side of membrane, carrier concentration in the solvent, and content of uranium in the feed solution. The experimental results showed a good quantitative agreement with the predicted results by the theory. As a result, it was found that the major uranium complexes are formed by the reaction of uramine with both ($UO_2(SO_4)_2^{2+}$) and ($UO_2(SO_4)_3^{4+}$). The principal findings in this study can be summerized as follows: (1)At near PH 1.3, the flux reached a maximum value. (2)The uranium flux increases with increasing the content of alumine 336 up to 30 volume percent, and then decreases again above this concentration. (3)The flux increases sharply with uranium concentration up to 1 g-u/l. (Author).

26365 (LA-UR–90-996) **A study of electrolytic tritium production.** Storms, E.K.; Talcott, C.L. Los Alamos National Lab., NM (USA). [1990]. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9003118–1: 1. annual conference on cold fusion, Salt Lake City, UT (USA), 28-31 Mar 1990). Order Number DE90008919. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Tritium production is being investigated using cathodes made from palladium and its alloys with various surface treatments. Three anode materials have been studied as well as different impurities in the electrolyte. Tritium has been produced in about 10% of the cells studied but there is, as yet, no pattern of behavior that would make the effect predictable. 15 refs., 4 figs., 6 tabs.

4008 Combustion, Pyrolysis, and High-Temperature Chemistry

Refer also to citation(s) 26045, 26253, 26552, 26557, 26780

26366 (AD-A–216019/0/XAB) **Wick-type liquid-metal combustion. Annual report, 15 October 1988-14 October 1989.** Chen, L.D.; Lyu, H.Y.; Hsu, K.Y. Iowa Univ., Iowa City, IA (USA).

Dept. of Mechanical Engineering. Oct 1989. 68p. Available from NTIS, PC A04/MF A01.

An experimental and theoretical investigation was conducted to study the wick combustion of lithium and sulfur hexafluoride. A single-line laser induced fluorescence thermometry with Li2 as fluorescence species was developed. The calibration experiments yielded promising results; refinements, however, are needed before the technique can be applied to combustion flame measurements. Wick combustion of ethanol and hexane in air as well as Li and SF6 was conducted in a vacuum chamber at atmospheric and subatmospheric pressures. The ethanol and hexane wick diffusion flames showed flame oscillations, similar to flame flickers in buoyant jet diffusion flames. The oscillation frequency was estimated in the range 5 to 8 Hz at the pressures examined. The flame stand-off distance was estimated in the range 5 to 8 Hz at the pressures examined. The flame stand-off distance was found to increase when the system pressure was decreased. The wick combustion of Li and SF6 resulted in a bright pinkish flame. The luminous zone appeared quite close to the wick surface at the condition examined. Near the complete consumption of lithium, the wick was burned out due to loss of liquid lithium as a heat sink. On the analysis, a conserved scalar approach was employed to model the wick flame. A single equation was obtain to describe the interface condition of the wick combustion. Numerical solutions were obtained for laminar wick diffusion flames. The prediction yields similarity profiles for both ethanol-air and Li-SF6 wick diffusion flames although nonsimilar governing equations were retained in the formulation.

26367 (CONF-8805106–, pp. 181-187) **Structure and stabilization of premixed and diffusion flames.** Law, C.K. (Univ. of California, Davis (USA)). Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

The influence of transport and kinetic processes on the structure, propagation, extinction, stabilization, and stability of laminar premixed and diffusion flames have been studied theoretically and experimentally. Results from two such studies are discussed. The first involves an asymptotic analysis of the propagation and stability of premixed flames in dissociation equilibrium. Results show that dissociation can facilitate the propagation rate of the flame for highly mobile dissociated species, and that it also has a stabilizing influence on flame-front thermal-diffusive instability. The second study involves an accurate experimental and numerical determination of the laminar flame speed and through it the demonstration that the mass burning rate of the flame can be sufficiently slowed down for weakly-burning flames under high pressures because of the enhanced significance of the chain termination over chain branching reactions.

26368 (CONF-8805106–, pp. 193-199) **Structure of turbulent premixed flames.** Cheng, W.K. (Massachusetts Institute of Technology, Cambridge (USA)); Lai, M.C.; Ferreira, L. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

The structures of statistically spherical premixed flames were visualized by a two dimensional flame imaging method. The evolution of a two dimensional section of the flames were recorded in high speed movie. From these images, a probability distribution of the burned gas as a function of the distance from the flame centroid was calculated. From the distribution, a wrinkled flame thickness may be defined. This thickness was found not to correlate with the turbulent diffusivity, but it was proportional to the turbulent eddy-turn-over time.

26369 (CONF-8805106–, pp. 200-208) **Droplet behavior in a counterflowing flame.** Puri, I.K. (Univ. of California, San Diego, La Jolla (USA)); Libby, P.A. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

Single droplets of n-heptane fuel are observed in a counterflowing, laminar nonpremixed flame which has well defined, variable velocity and state fields. The trajectory and change in size of droplets are observed photographically when introduced in either the fuel or oxidizer streams. Significant discrepancies between measurement and prediction based on various engineering models are found to exist when the droplets encounter the reaction zone of the flame. Possible source of these discrepancies and future work at their clarification are discussed.

26370 (CONF-8805106–, pp. 209-216) **Transport processes associated with droplet combustion.** Dwyer, H.A. (Sandia National Lab., Livermore, CA (USA)); Sanders, B.R. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

The time-dependent history of a burning octane droplet has been computed. The purposed of the calculation is to understand the interplay between the transport phenomena, thermodynamics, an the chemical kinetics for a droplet decelerating from the initial Reynolds number condition of one hundred to a low Reynolds number flow. The results show that the drag and heat transfer characteristics are significantly different than those for an isothermal solid sphere, but that a semi-empirical drag correlation can adequately describe the computed drag results. The heat transfer characteristics of the flow are not described well by a semi-empirical correlation, primarily due to the movement of the flame from the rear towards the forward stagnation region of the droplet.

26371 (DOE/METC–89/6099, pp. 246-250) **The chemistry of the interaction of sodium and sulfur in flames.** Steinberg, M. (Univ. of California, Santa Barbara (USA)); Schofield, K. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The program objectives are the identification of the dominant reactions controlling sodium/sulfur chemistry, the development of a kinetic model for the gas phase chemistry of the system, and a more quantitative description of the sodium/sulfur species distribution in the hot gases in combustion driven gas turbines. Temperature, (OH), and (Na) profiles have been measured in series of fuel rich and lean $H_2/O_2/N_2$ and rich $C_2H_2/O_2/N_2$ flames with and without added sulfur. SO_2 was added to the lean flames and H_2S to the rich flames to minimize thermal contributions of these additives. The measurements cover a wide range of stoichiometries with flame temperatures varying from 1650 to 2400 K. Most of the current effort is directed toward modeling the chemistry in the $H_2/O_2/N_2$ flames. Since sodium/sulfur compound formation is greater in the rich flames, the authors have focused the analysis on this system. Of the possible sodium/sulfur compounds noted above, NaSO appears to be a most promising primary product and they initially have examined this possibility. Results are discussed.

26372 **Photoionization mass spectrometric studies of free radicals.** Berkowitz, J. (Argonne National Lab., IL (USA)). *Accounts of Chemical Research (USA),* 22(12): 413-420 (Dec 1989). DOE Contract W-31109-ENG-38.

Free radicals have been fascinating to chemists for decades, partly because of their important but emphemeral nature as intermediates in chemical reactions, e.g., combustion and atmospheric processes. For example, the reaction $OH + CO \rightarrow H + CO_2$ is the dominant source of CO_2 in the oxidation of hydrocarbons and is important in the chemistry of the upper atmosphere and in the formation of chemical smog. This reaction is believed to proceed through a COOH intermediate, but until very recently, this species had not been detected in the gas phase. The depletion of ozone in the stratosphere is attributed to the reaction of the free radical ClO with O_3. The chemical vapor deposition method of producing solid-state devices based on Si or Ge employs a plasma containing free-radical hydrides of Si and Ge. We have shown that the direct application of eq 1 and 2 to determine the dimerization energy of BH_3 by measuring its ionization potential and its appearance potential from B_2H_6 is inappropriate for this system. However, a

rather lengthy analysis of the data leads to a dimerization energy of 34.3-39.1 kcal/mol, in good agreement with ab initio calculations. Preliminary results from our B_2H_5 and B_2H_4 studies indicate that $D_0(B_2H_5\text{-}H) \leq 102.7$ kcal/mol, but $D_0(B_2H_4\text{-}H)$ is much weaker, $\approx$ 40.1 kcal/mol.

26373 Coal pyrolysis. Stock, L.M. (Argonne National Lab., IL (USA)). *Accounts of Chemical Research (USA),* 22(12): 427-433 (Dec 1989).

Considerable technological progress in coal utilization has been made in recent years, with two new major gasification installations in operation in the United States. One at Coolwater, CA, produces gas turbine fuels for power generation; the other, at Grand Forks, ND, produces methane. It is now well appreciated in the technological community that the discovery of new, more economically feasible methods for the fuller utilization of coal in the United States for energy generation, transportation fuels, chemical feedstocks, and other related purposes will require a rather thorough appreciation of the chemical nature of its constituents and their patterns of reactivity. The work of Juntgen, Suuberg, Solomon, and others presents a unifying view of the kinetic patterns for the decomposition of coal and offers insight concerning the sources and yields of the various gaseous products formed during coal pyrolysis. The establishment of the relationship between the constitution of the coal and the ultimate product distribution realized in pyrolysis has been a common goal. The recent investigations provide new information on the probable pathways for the formation of gaseous products during the coal pyrolysis in the absence of added dihydrogen.

26374 Detection of C_5 in the circumstellar shell of IRC + 10216. Bernath, P.F. (Univ. of Arizona, Tucson (USA)); Hinkle, K.H.; Keady, J.J. *Science (Washington, D.C.) (USA),* 244(4904): 562-564 (5 May 1989).

The C_5 molecule has been identified in the infrared spectrum of the prototypical obscured carbon star, IRC + 10216. In addition to their astrophysical importance, pure carbon chain molecules such as C_5 are of interest in the chemistry of flames and propellants. 27 refs., 1 fig., 2 tabs.

42 ENGINEERING

Refer also to citation(s) 26508

4202 Facilities, Equipment, and Techniques

Refer also to citation(s) 25829, 25884, 26224, 26411, 26446, 26505, 26536, 26542, 26564

26375 (AD-A-216241/0/XAB) **Liquid-metal flows in current collectors for homopolar machines: Fully developed solutions for the primary azimuthal velocity. Formal report.** Talmage, G.; Walker, J.S.; Brown, S.H.; Sondergaard, N.A. David Taylor Research Center, Bethesda, MD (USA). Jul 1989. 15p. Available from NTIS, PC A03/MF A01.

Pub. in Physics of Fluids A, Vol. 1, No. 7, 1268-1278(Jul 1989).

Liquid metals in the small radial gaps between the rotors and stators of homopolar machines represent low-resistant electric current collectors. Design predictions for these liquid-metal current collectors require a thorough knowledge of liquid-metal flows in a narrow gap between a fixed and a moving surface, with a strong applied magnetic field and a free surface beyond each end of the gap. The radial and axial velocities in the secondary flow are reduced by a strong axial or radial magnetic field. For a sufficiently strong field, the azimuthal momentum transport by the secondary flow can be neglected. This assumption reduces the problem for the primary azimuthal velocity to a fully developed magnetohydrodynamics duct flow problem with a moving wall and two free surfaces. Asymptotic solutions for large Hartmann numbers are presented for skewed magnetic fields with both radial and axial components. Collectors without any electrical insulation or with insulation on the stator sides, or rotor sides, or both are considered. Solutions for a purely axial magnetic field and arbitrary Hartmann numbers are also presented.

26376 (AD-A-216288/1/XAB) **Incompressible-flow friction factors in a simulated heat pipe. Master's thesis.** Mayhew, J.E. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Dec 1989. 70p. (AFIT/GAE/ENY--89D-23). Available from NTIS, PC A04/MF A01.

Porous pipes with blowing and suction are used to simulate the vapor flow in heat pipes. A computer program for steady, two-dimensional, boundary-layer flow has been written to find friction factors using the axial pressure distributions measured in an experiment with incompressible flow in a porous pipe. The results for some existing experimental data are presented and compared to previously published solutions for fully-developed flow. Also, this program has been modified to numerically simulate porous pipe flow without using axial pressure distribution as an input. This simulation program furnishes additional results for comparison to the original data reduction program. It is observed that the simulation program accurately computes friction factors and flow separation points in a porous pipe with low radial Reynolds number.

26377 (CONF-8805106--, pp. 43-50) **Recovering 3-D translational velocity and establishing stereo correspondence from binocular image flows.** Duncan, J.H. (Univ. of Maryland, College Park (USA)); Li, Lingxiao. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

In this paper, image sequences from stereo cameras that are rigidly mounted in a parallel configuration on a platform are analyzed. Due to an unknown relative translational velocity between the platform and the objects being viewed, an image flow is generated in the left and right cameras. Equations are derived that provide a linear relationship between the relative translational velocity of the platform and sums over the two images of the measured coordinates of image features, the measured velocities of these features, and the products of these measurements. These equations are easily solved for the three components of translational velocity. The same equations are then used, with the computed velocities, as a constraint to find features in one image that correspond to given features in the other image. Preliminary experiments with synthetic image indicate that the method gives accurate results even in the presence of noise.

26378 (DP-MS--88-66-Rev.1) **Remote robotic technology development for the new plutonium production facility: Revision 1.** Heckendorn, F.M.; Duncan, N.D. Westinghouse Savannah River Co., Aiken, SC (USA). [1989]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-890864--6-Rev.1: 3. American Glovebox Society annual conference and equipment display, Denver, CO (USA), 21-24 Aug 1989). Order Number DE90009299. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Savannah River Laboratory (SRL) in Aiken, South Carolina, is developing remote robotics technology, in conjunction with the Savannah River Plant (SRP), to support a new generation of plutonium production facilities. The present conventional glove box facilities are based on 1950's design technology and are obsolete. Future potential process changes and possible additional tasks increase the need for a newer technology facility. The design objectives for the new facilities are to minimize personnel exposure, both operating and maintenance, and to maximize SNM accountability and safeguards. Therefore, the process systems would be contained in a totally remote environment designed for no personnel entry over its lifetime. These concepts required new robotic and robotic interface technologies. The conceptual design is complete, and work is progressing in the development and demonstration phases. The robotic approaches taken are described in this paper, in the context of the overall facility design, which is specifically tailored for robotics. 4 figs.

26379 (EPRI-GS--6745) **1989 EPRI [Electric Power Research Institute] gas turbine procurement seminar: Proceedings.** Sanders, C.F. (Energy Systems Associates, Tustin, CA (USA)); Miller, M.N. Electric Power Research Inst., Palo Alto, CA (USA); Energy Systems Associates, Tustin, CA (USA). c Mar 1990.

325p. Sponsored by Electric Power Research Institute. (CONF-8909317–: 1989 EPRI gas turbine procurement seminar, Atlanta, GA (USA), 14-15 Sep 1989). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A workshop addressing reliability, availability, and maintainability in electric gas turbine procurement, was held September 14–15, 1989 in Atlanta, Georgia. Attendees were comprised of 40 persons representing 26 electric utilities. The balance of the 40 attendees consisted of representatives from the Electric Power Research Institute (sponsors of the Seminar), invited speakers, and the contractor responsible for the organization and administration of the workshop, Energy Systems Associates. During the 1989 workshop, nine presentations were given — again the emphasis being on sharing experiences in gas turbine procurement. The presentations addressed reliability, availability, and maintainability (RAM), information on warranties utilized in gas turbine procurement, selective catalytic reduction, a regulatory status report, along with several examples of actual electric utility procurement experiences. Individual projects are processed separately for the data bases.

26380 (KAERI/RR–721/88/ST2) **Structural design by CAD system.** Kim, Jhin Wung (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Shim, Jae Ku; Kim, Sun Hoon; Kim, Dae Hong; Lee, Kyung Jin; Choi, Kyu Sup; Choi, In Kil; Lee, Dong Yong. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 146p. (In Korean). Order Number DE90623212. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

CAD systems are now widely used for the design of many engineering problems involving static, dynamic and thermal stress analyses of structures. In order to apply CAD systems to the structural analysis and design, the function of hardwares and softwares necessary for the CAD systems must be understood. The purpose of this study is to introduce the basic elements that are indispensible in the application of CAD systems to the analysis and design of structures and to give a thorough understanding of CAD systems to design engineers, so as to participate in the further technological developments of CAD systems. Due to the complexity and variety of the shape and size of the nowa-days structures, the need of new design technologies is growing for more efficient, accurate and economical design of structures. The application of CAD systems to structural engineering fields enables to improve structural engineering analysis and design technologies and also to obtain the standardization of the design process. An active introduction of rapidly developing CAD technologies will contribute to analyzing and designing structures more efficiently and reliably. Based on this report of the current status of the application of CAD systems to the structural analysis and design, the next goal is to develop the expert system which enables to perform the design of structures by CAD systems from the preliminary conceptual design to the final detail drawings automatically. (Author).

26381 (KAERI/RR–784/88) **Construction of irradiated material examination facility-basic design.** Ro, Seung Gy (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Kim, Eun Ka; Hong, Gye Won; Herr, Young Hoi; Hong, Kwon Pyo; Lee, Myeong Han; Baik, Sang Youl; Choo, Yong Sun; Baik, Seung Je. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Feb 1989. 230p. (In Korean). Order Number DE90623223. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The basic design of the hot cell facility which has the main purpose of doing mechanical and physical property tests of irradiated materials, the examination process, and the annexed facility has been made. Also basic and detail designs for the underground excavation work have been performed. The project management and tasks required for the license application have been carried out in due course. The facility is expected to be completed by the end of 1992, if the budgetary support is sufficient. (Author).

26382 (KAERI/RR–792/88) **Study on the safety control of the radiation and nuclear materials.** Park, Chong Mook (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Ro, Seung Gy; Choi, Byung Il; Shin, Hee Sung; Ji, Pyung Gook; Kwak, Sang Soo; Park, Yong Young; Kim, Tae Wook; Kim, Bong Gy; Yoon, Bong Kun. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Feb 1989. 189p. (In Korean). Order Number DE90623222. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The contents included in this report are the radiological control of the post irradiation examination (PIEF) and radioactive waste treatment facilities (RWTF), the development of environmental radiation dose measurement, the dispersion calculation of radioplume from stack, and criticality analysis of spent fuel shipping cask(KSC-4) designed by KAERI for shipping 4 PWR spent fuel assemblies. The results of the radiological surveillance of the PIEF and NWTF within the period of Jan. to Dec. 1988 are described. The environmental dose rate of radiation emitting from soil was determined by HPGe detector and spectrum-dose conversion function theoretically developed in this work [The determination of the spectrum-dose conversion was published in J. of the Korean Association for Radiation Protection, vol 13, No 2, 29-39(1988), in English]. The radioplume dispersion calculation was performed by using plume dispersion model and was compared with that under severe accidental dispersion condition. The criticality of the KSC-4 cask was analyzed using KENO-IV and 19 group cross section set generated using AMPX generation code, and was found to satisfy the safety criticality limit recommended by 10CFR71 [The criticality analysis of the KSC-4 cask was published in J. of the Korean Association for Radiation Protection, vol.14, No. 1, 56-65(1989),in Korean]. (Author).

26383 (KCP–613-4266) **A solution level indicator system: Final report.** Barben, C.L. Allied-Signal Aerospace Co., Kansas City, MO (USA). Kansas City Div. Apr 1990. 92p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00613. Order Number DE90007939. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

A computer-based system was developed and built to monitor liquid volumes used for chemical analyses on a laboratory robot. The robot performs dilutions and titrations for production solutions to analyze inherent component concentrations. For successful testing, sufficient analytical chemicals (titrants) and water must exist to perform each analysis. This system provides a quick and convenient display of volumes for the operator to maintain an adequate supply of chemicals and water for proper robot operation. In addition, the system monitors liquid volume of post-analysis waste mixtures in the effluent barrel to preclude overfilling the container. 3 refs., 14 figs., 2 tab.

26384 (ORNL/CSD/FTR–3549) **[Shielding calculations for transport casks]: Foreign trip report, February 23–March 4, 1990.** Parks, C.V.; Broadhead, B.L. Oak Ridge National Lab., TN (USA). 12 Mar 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. Order Number DE90009297. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The overall purpose for the trip stems from the interest by the US Department of Energy in ensuring that well-qualified calculational tools and methods are available for accurate analysis of transport and storage casks loaded with spent fuel or high-level waste. The OECD-NEA Committee on Reactor Physics has established several Working Groups to allow an international intercomparison of calculational methods and codes for the analysis of transport casks. The Working Group first met in June 1986 and had its second meeting in May 1987. This report describes the fourth meeting of the Working Group, which was attended by the travelers.

26385 (ORNL/TM–11435) **A new approach to solve the kinematics resolution of a redundant robot.** Belmans, P.; Culioli, J.C. Oak Ridge National Lab., TN (USA). Mar 1990. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. (CESAR–89/53). Order Number DE90010213. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A classical redundancy resolution scheme for an m-degree of freedom robot involves the numerical or symbolic computation of the Moore-Penrose pseudo-inverse of the Jacobian matrix, which in turn leads to a least norm solution for the joint velocities. Since the Jacobian matrix may be ill-conditioned, the computation of the inverse may often turn out to be lengthy and/or inaccurate. In this paper, we propose an alternative method to find this least norm solution. Namely we modify the original underdetermined problem by transforming it into a set of determined new problems. We compute

in parallel the solutions of these problems and find their least norm simplex combination. We prove that if the dimension of the task-space is n, we need only (m – n + 1) such solutions. We also show that the approach can take into account obstacle avoidance and maximum of manipulability or any other type of analytical criterion. We apply the method to a planar redundant arm. 11 refs., 2 figs.

26386 (PB–90-161571/XAB) **Static exciters for induction generators. Phase 1. Final report, June 1987-April 1989.** Brennen, M.B. Westinghouse Electric Corp., Pittsburgh, PA (USA). Science and Technology Center. Oct 1989. 84p. Available from NTIS, PC A05/MF A01.

Add-on equipment is being developed for existing or newly installed induction cogenerators that allows emergency standby operation during utility outages. The electrical and mechanical design effort included evaluating power circuit configurations; studying utility interconnection requirements; simulating the control behavior of standby induction cogenerators; designing the power, control and protection circuits of the exciter; and estimating manufacturing costs. A capacitor assisted, pulse width modulated (PWM), voltage sourced inverter was selected for the exciter power circuit (CA-VSI). Diagrams are included.

26387 (PB–90-161670/XAB) **Metrology for electromagnetic technology: A bibliography of NIST (National Institute of Standards and Technology) publications.** DeWeese, M.E. National Inst. of Standards and Technology (NEL), Gaithersburg, MD (USA). Center for Electronics and Electrical Engineering. Aug 1989. 56p. (NISTIR–89/3921). Available from NTIS, PC A04/MF A01.

Also available from Supt. of Docs. Supersedes PB–89-147847.

The bibliography lists the publications of the personnel of the Electromagnetic Technology Division of NIST during the period from January 1970 through publication of the report. A few earlier references that are directly related to the present work of the Division are also included. The Electromagnetic Technology Division was formed during the reorganization of the National Bureau of Standards (now the National Institute of Standards and Technology) in April 1978 by combining parts of the former Electromagnetics and Cryogenics Divisions. It develops measurement methods and standards and provides metrological support for laser systems, optical communication equipment, cryoelectronics, superconductors, and other unusual electrical engineering materials.

26388 (PB–90-858606/XAB) **Cryogenic refrigeration. February 1972-January 1990 (A Bibliography from the International Aerospace Abstracts data base). Report for February 1972-January 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 121p. Available from NTISPC N01/MF N01.

U.S. sales only.

This bibliography contains citations concerning cryogenic refrigeration or cryocooling. Design, development, testing, and evaluation of cryogenic cooling systems are discussed. Design applications in spacecraft, magnet cooling, superconductors, liquid fuel storage, radioastronomy, and medicine are presented. Material properties at cryogenic temperatures and cryogenic rocket propellants are considered in separate bibliographies. (Contains 262 citations fully indexed and including a title list.)

26389 (PB–90-858721/XAB) **Cryogenic coolers and refrigerators. February 1972-October 1989 (A Bibliography from the US Patent data base). Report for February 1972-October 1989.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 57p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning cryogenic cooling equipment and cryogenic refrigerators. Associated components such as drive motors, insulation, temperature controls, vibration damping, actuators, pumps, and heat exchangers are discussed. Applications of cryogenic refrigeration and materials properties at cryogenic temperatures are considered in separate bibliographies. (Contains 123 citations fully indexed and including a title list.)

26390 **Niobium-1 percent zirconium/potassium life-test heat pipe design and testing.** Sena, J.T. (Los Alamos National Laboratory, NM (USA)); Merrigan, M.A. vp. of AIAA, Aerospace Sciences Meeting, 28th. AIAA, Washington, DC (US) (1990). (AIAA-Paper–90-0063;CONF-900153–: 28. AIAA aerospace sciences meeting, Reno, NV (USA), 8-11 Jan 1990).

Studies are being conducted to develop lifetime performance data on heat pipes for the SP-100 reference flight system radiator. Experimental lifetime performance studies currently in progress use niobium-1 percent zirconium (Nb-1Zr) heat pipes with potassium (K) as the working fluid. A heat pipe life-test matrix has been developed for testing nine heat pipes; the variable parameters of the experimental matrix are established as steady operating temperature and input heat flux density. Impurity levels are being evaluated in the heat pipe materials before and after testing. Eight Nb-1Zr/K heat pipes were designed, fabricated, and tested. These are gravity-assist heat pipes operating in a reflux mode. The heat pipes are operating at between 800 and 900 K, with heat input fluxes of 13.8 to 30 W/sq cm. Two of the heat pipes have been in operation for over 13,000 hours, three over 10,000 hours, and three over 7000 hours. 5 refs.

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Refer also to citation(s) 25668, 25674, 25773, 25793, 25978, 26045, 26160, 26432, 26516, 26527

26391 (CONF-8805106–, pp. 1-8) **Heat transfer in three-dimensional turbulent boundary layers.** Eaton, J.K. (Stanford Univ., CA (USA)); Pauley, W.R.; Anderson, S.D. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

This paper is an interim report on a long term project to study the heat transfer behavior of three dimensional turbulent boundary layers. The first phase of the work was examination of 2D boundary layers perturbed by a weak longitudinal vortex. The second phase examined plane of symmetry flows and boundary layer interactions with stronger vortices. The third phase is examining a highly skewed pressure driven three dimensional boundary layer. The paper presents highlights of the results of phases 2 and 3.

26392 (CONF-8805106–, pp. 9-17) **Turbulent transport of heat within a vortex/shear-layer.** Eibeck, P.A. (Univ. of California, Berkeley (USA)). Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

A new research program has been established to examine the turbulent transport of heat in flows containing significant longitudinal swirl. This will be accomplished by making extensive fluid dynamic and heat transfer measurements, including the mean velocity and temperature fields, Reynolds stress and turbulent heat flux distributions, and mean Stanton numbers within a cross plane of three different flows. The flows to be studied will be the single vortex embedded in a turbulent boundary layer, the trailing legs of a horseshoe vortex, and flow downstreams of a spanwise row of obstacles. The usefulness of this data will be demonstrated by using it to develop a phenomenological model of the dominant heat transfer mechanisms. A simple computational scheme will then be applied to predict the local heat transfer behavior in these complex, three-dimensional flows.

26393 (CONF-8805106–, pp. 18-25) **Experimental and theoretical studies of vertical annular liquid jets.** Chigier, N. (Mechanical Engineering Department, Pittsburgh, PA (USA)); Ramos, J.I.; Kihm, K. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

The stability, dynamics and convergence of vertical annular liquid jets as a function of the initial radius, sheet thickness and velocity have been studied. The influence of the Froude, Reynolds, and Weber numbers and geometry on convergence and stability are examined. Analytical and numerical techniques were used to solve

the steady state and time-dependent form of the Navier-Stokes equations for inviscid curtains. Experiments were carried out on annular liquid curtains with an initial radius of 50 mm and initial sheet thicknesses of 0.5 and 1.0 mm. Three Froude numbers have been studied: 1.27, 4.27 and 8.87 by variation of the liquid flow rate. Pressure within the curtains was varied progressively from 0 to 3 Pa. Several flow regimes were found: (a) nonpressurized, (b) pressurized, (c) oscillating, and (d) punctured. Curtain shape and convergence length were determined by photography. Velocity in the liquid curtain was measured by Laser Doppler Anemometry. The variation of liquid film thickness with axial distance was determined. Good agreement was found between predictions and experiments.

26394 (CONF-8805106–, pp. 26-34) **Mass transfer in separated flows.** Goldstein, R.J. (Univ. of Minnesota, Minneapolis (USA)); Jabbari, M.Y. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

Separation occurs in a variety of flow environments, including flows in heat exchangers, in turbomachinery passages, at the entrance to pipes, at the roots of protuberances, over blunt bodies, etc. Separation is generally accompanied by a reverse flow which may evolve into one or more vortices. A reattachment may also follow. The multiple vortices and the reattachment make the flow field very complex. Consequently, the transport processes in the region become complicated and unpredictable by convectional means. Mass (heat) transfer in several separated flows investigated. In many of these flow a vortex system develops in the separated region. These vortices can cause a substantial variation in the local transport coefficient over a relatively small area. This variation appears to be due to separate stagnation and stagnant (slowly recirculating) flow regimes created by inward and outward counter rotating vortices.

26395 (CONF-8805106–, pp. 35-42) **Stability control of leakage-flow channels.** Grotberg, J.B. (Northwestern Univ., Evanston, IL (USA)); Prince, A.; Reiss, E.L.; Mulcahy, T.M. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

Conditions for self-excited vibrations of channels conveying leakage flows are identified, including experimental results for an unconstricted slip joint. Several simple mathematical models of the interaction of the elastic channels and the flow are described, which should be useful for the identification and control of the structural instabilities.

26396 (CONF-8805106–, pp. 51-58) **A linear-eddy model of turbulent scalar transport and mixing.** Kerstein, A.R. (Sandia National Lab., Livermore, CA (USA)). Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

The linear-eddy modeling approach involves in the representation of a spatially developing flow by a simulation of the time development along a transverse line moving with the mean flow. Scalar quantities evolve by Fickian (molecular) diffusion and by randomly occurring spatial rearrangements, representing turbulent convection. A formulation denoted the block-inversion model is adapted here for application to turbulent planar shear layer mixing. Predictions of the mixing rate dependence on Reynolds and Schmidt number are consistent with measurements.

26397 (CONF-8805106–, pp. 59-62) **Three-dimensional vortex reconnections.** Novikov, E.A. (Univ. of California, San Diego, La Jolla (USA)). Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

Various three-dimensional vortex reconnections, including successive reconnections, in a free flow and in a boundary layer with a shear flow are studied numerically by the method of three-dimensional solenoidal vortex singularities (vortons). The results of these numerical experiments are in a good agreement with the laboratory observations. Comparison with other methods of three-dimensional vortex simulation have been made. For the vortex ring, it is shown analytically that interaction energy of vortons gives correct total kinetic energy of the flow.

26398 (CONF-8805106–, pp. 85-91) **Inertial coupling in two-phase flow.** Wallis, G.B. (Dartmouth College, Hanover, NH (USA)). Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

This paper summarizes the results of a recent and ongoing study of the potential two-phase flow of a dispersion. Firstly, the net mass, momentum and kinetic energy fluxes, the interphase pressure and the state of average stress of the dispersed phase are derived for motion of a single sphere. This is then generalized for the motion of an arbitrary body, revealing that the phenomena are all closely related through the coefficient of added mass. Similar results are then obtained for a suspension, obtaining expressions for the average momentum flux, kinetic energy density, interface pressure, particle stress, added mass coefficient, equations of motion, effective Bernoulli equation and forces on stationary particles in gradients or discontinuities in void fraction. These results are all derivable from a single function of void fraction that may be approximated by an expression derived by Maxwell over a century ageo. A consistent body of theory is thus obtained that may be useful for comparing with hypothesized general equations, such as those obtained in the two-fluid model by way of averaging techniques. Of course, practical flows exhibit additional important viscous effects that probably need to be handled empirically.

26399 (CONF-8805106–, pp. 92-99) **Lubricated pipelining: Stability of core-annular flow II.** Joseph, D.D. (Univ. of Minnesota, MN (USA)); Hu, Haochuan. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

In this paper, the authors study the linearized stability of three symmetric arrangements of two liquids in core-annular Poiseuille flow in round piper. Deferring to one important application, they say oil and water when they mean more viscous and less viscous liquids. The three arrangements are (1) oil is in the core and water on the wall, (2) water is in the core and oil is outside and (3) three layers, oil inside and outside with water in between. The arrangement in (3) is the model for lubricated pipelining when the pipe walls are hydrophobic and it has not been studied before. The authors have calculated neutral curves, growth rates, maximum growth rate, wave numbers for maximum growth and the various terms which enter into the analysis of the equation for the evolution of the energy of a small disturbance. The energy analysis allows one to identify the three competing mechanisms underway, interfacial tension, interfacial friction and Reynolds stress.

26400 (CONF-8805106–, pp. 108-115) **Closure conditions for two-fluid models of two-phase flow.** Arnold, G.S. (Rensselear Polytechnic Institute, Troy, NY (USA)); Drew, D.A.; Lahey, R.T. Jr. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

An ensemble cell averaging techniques has been applied to the derivation of interfacial momentum transfer. It has been shown to be more general than volumetric cell averaging, and, some of the inadequacies of volumetric cell averaging have described. It has been shown that ensemble cell averaging corrects these problems.

As a consequence, ensemble averaging is recommended for the formulation of two-fluid models of two-phase flows. The authors have derived an appropriately averaged entropy equation and applied it to sets of constitutive equations found in several state-of-the-art transient multiphase flow computer codes. It was found that all current generation multiphase computer codes violate the second law of thermodynamics. It was found that the conservation and constitutive equations used neglected some important interfacial effects. In particular, an interfacial flow work term $^{tau}{}_{i}\ (p_i/^{rho}{}_{i})_{i}$ was neglected. An acceptable set of constitutive equations for a continuous liquid phase multiphase flow models is an important means for assessing those models. The approach discussed herein was restricted to consideration of the continuous liquid phase conservation equations and their associated closure conditions. However, this phase, as well as to models for the corresponding mixture equations. Indeed, the out unacceptable two-fluid modeling assumptions.

26401 (CONF-8805106–, pp. 116-122) **Temporal and spatial patterns in reaction-diffusion systems.** Swinney, H.L. (Univ. of Texas, Austin (USA)). Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

Progress in the understanding of bifurcations and chaos in homogeneous nonequilibrium chemical reactions has been achieved using continuous flow stirred tank reactors in which a reaction can be maintained indefinitely in a well-defined nonequilibrium state. In contrast, studies of spatial patterns in unstarred reactors have been conducted under transient conditions, where a pattern (e.g., formed on a filter paper) evolves continuously towards thermodynamic equilibrium. Recently this group has developed continuous flow unstarred reactors that now make it possible to study spatial patterns in systems maintained indefinitely in well-defined nonequilibrium states. Thus the formation of sustained spatial patterns and transitions between different patterns can be studied as a function of external control parameters, as is described in this paper. The authors also describes briefly a method developed for the reduction of noise in time series data an a technique developed for detecting the flow of information from one spatial region to another.

26402 (CONF-8805106–, pp. 144-151) **Heat transfer in porous media with internal heat generation - application to porous radiant burners.** Tong, T.W. (Arizona State Univ., Tempe (USA)); Sathe, S.B. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

This paper reports a numerical study of the heat transfer characteristics of porous radiant burners. A one-dimensional conduction, convection and radiation model with internal heat generation was employed. Non-local thermal equilibrium between the gas and solid phases is accounted for by using separate energy equations for the two phases. The solid matrix is assumed to emit, absorb and scatter radiant energy. The governing equations are solved using a numerical iterative procedure. The effects of the various factors on the radiant output are determined. It is revealed that for maximizing the radiant output from the burner, large optical thicknesses and high heat transfer coefficients between the solid and gas phases are desirable. Also, low solid thermal conductivities, scattering albedos and flow velocities produced high radiant output.

26403 (CONF-8805106–, pp. 152-158) **The use of dye tracers in the study of free convection in porous media.** Jones, M.C. (National Bureau of Standards, Boulder, CO (USA)); Perkins, R.A. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

A new experimental approach based on age distribution functions is described for the study of free convection in porous media. Fiber optic probes are being used to track the dispersion of a fluorescent dye by he convective flow. The initial focus is on three-dimensional flows in rectangular boxes with vertical temperature gradients.

26404 (CONF-8805106–, pp. 159-171) **Transport processes in porous media.** Catton, I (Univ. of California, Los Angeles (USA)); Adnani, P.; Chung, M. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

Transport processes through a fluid saturated porous media are modeled using a stochastic phenomenological model. The effective transport properties such as the thermal conductivity of the porous media and the total drag are determined using the stochastic model. The results from the model are then used to study heat transfer in the porous Bernard problem. Several aspects of two-phase flow, normal and parallel to porous media layers with different properties, were observed experimentally. Two-phase flow through multi-dimensional beds with or without a heat source were also analyzed numerically. The predictions of pressure and void fraction compared well with experimental data. Dryout heat fluxes and temperature distributions for beds with a heat source were calculated.

26405 (CONF-8805106–, pp. 172-180) **Transport properties of disordered heterogeneous media from the microstructure.** Torquato, S. (North Carolina State Univ., Raleigh (USA)). Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

The authors has studied and computed rigorous bounds on the conductivity, elastic moduli, reaction rate constant, and fluid permeability of heterogeneous media which depend upon the microstructure through different types of correlation functions. To illustrate the use of variational principles he discusses the fluid permeability problem in some detail. A means of statistically characterizing the microstructure is described. Clustering in continuum-percolation models is also examined.

26406 (CONF-8805106–, pp. 100-107) **Nonlinear saturation of core-annular flow instabilities.** Frenkel, A.L. (City Univ., New York, NY (USA)). Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

Core-annular-film flow (CAFF) is a Poiseuille flow in a circular tube of two coaxial fluids, when the wall fluid is a thin film. The surface tensiondestabilizes ratio κ, the viscosity ratio m, the Reynolds number Re, and the surface-tension number J - can be such that the unstability saturates at small amplitudes interface oscillations. Thus the film, the core, and the interface do not break up. The author finds several domains of such topologically-stable CAFFs in the (κ, m, Re, J)-space, with $Re<<1$, or $Re\sim1$, or $Re>>1$. Dispresive terms appear in the nonlinear equation of interface evolution when $m \neq 1$. They lead to periodic or solitary waves, the length- scale being selected by small surface-tension terms. When the film is the less viscous fluid, dissipative effects specific tom $\neq 1$ can render CAFF even linearly stable.

26407 (CONF-8805106–, pp. 123-128) **Diffusion and dispersion in porous media with percolation thresholds.** Keyes, T. (Boston Univ., MA (USA)); Palmer, B.; Ohtsuki, T. Argonne National Lab., IL (USA). 1988. From 6. symposium on energy engineering sciences; Argonne, IL (USA); 4-6 May 1988. In *Proceedings of the sixth symposium on energy engineering sciences: Flow and transport in continua.* Order Number DE88016751. Available from NTIS, PC A11/MF A01.

Transport problems are considered in two models of porous media, the Lorentz gas and a bond percolation network. Both model systems have percolation thresholds at which transport must cease-a critical scatter density in the Lorentz gas and a critical fraction of broken bonds in the bond model. The self diffusion is

calculated in the Lorentz gas via both the self consistent repeated ring kinetic equation and via a new approach, stochastic computer simulation. Agreement with computer simulations is quite good, except for densities very close to percolation. Dispersion of material in a flowing fluid is studied n a bond percolation network with real-space renormalization. Noninteger-power-law dependences upon time and strength of dispersion, are euclidiated, as is the vanishing of the weak flow # (low Peclet number) regime at the percolation threshold.

26408 (CONF-8910319–3) **Modeling the temperature dependence of the thermal conductivity of aluminum nitride.** Dinwiddie, R.B. (Oak Ridge National Lab., TN (USA)); Onn, D.G. Oak Ridge National Lab., TN (USA). [1989]. 12p. Sponsored by University of Delaware; U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From 21. international thermal conductivity conference; Lexington, KY (USA); 15-18 Oct 1989. Order Number DE90009428. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Data on the thermal conductivity of commercially available aluminum nitride substrates, over the temperature range of 20-500 K, is analyzed using the Klemens-Callaway model. Parameters in this model which include crystallite size and impurity concentration, are determined through a nonlinear least squares fitting routine. The resulting parameters are compared with values obtained from other experimental techniques such as scanning electron microscopy (SEM) and proton induced x-ray emission (PIXE). A graphical method has been developed for the estimation of impurity concentration and crystallite size from low temperature thermal conductivity data. 19 refs., 3 figs., 3 tabs.

26409 (DOE/ER/13759–3) **Experimental study of solidification under mixed convection conditions: Annual performance report.** Campbell, J.S.; Incropera, F.P. Purdue Univ., Lafayette, IN (USA). Heat Transfer Lab. Feb 1990. 156p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER13759. Order Number DE90009210. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

An experimental study has been performed for solidification in a mixed convection environment. Specifically, solidification of water in flow through a parallel plate channel has been considered. The study included both the vertical and inclined orientations, as well as aiding and opposing buoyancy forces. Overall heat transfer data, solid layer morphology, and flow visualization data were obtained. Buoyancy forces in the assisting vertical channel orientation were found to enhance heat transfer, inhibit solid layer growth, and produce a nearly stagnant region in the channel core. In the opposing vertical orientation, the resulting flow field was unsteady, and intermittently turbulent. For inclined channels, buoyancy forces resulted in the formation of a longitudinal vortex flow structure which had the effect of creating grooves, or spanwise variations, in the solid layer. Heat transfer was found to be enhanced over the vertical case for all channel inclinations up to 60 deg. 33 refs., 64 figs., 4 tabs.

26410 (KAERI/AR–299/89) **A study on the thermal hydraulics in rod bundles.** Chung, Moon Ki (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Yang, Sun Kyu. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Mar 1989. 304p. (In Korean). Order Number DE90623207. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

In order to improve the thermal hydraulic characteristics of the nuclear reactor core, it is necessary to obtain better understanding of the coolant flow and the enthalpy distribution in complex rod bundle geometries. The purpose of this report is to obtain a comprehensive survey on the thermal hydraulic in rod bundles from both experimental and numerical point of view. From references on experimental study, measurement methods and results of the flow velocity and the pressure drop in the subchannels of rod bundles are expressed. The microscopic flow characteristics of the subchannels and spacer grid effect on the flow structure are described. Physical phenomena and measurement methods of the secondary flow are also described. From references on the numerical study, general numerical methods are expressed. Numerical studies on the laminar flow and turbulent flow such as 1-equation and 2-equation model are reviewed.(Author).

26411 (PB–90-155870/XAB) **Apparatus for measuring high-flux heat transfer in radiatively heated compact exchangers.** Olson, D.A. National Inst. of Standards and Technology (NEL), Boulder, CO (USA). Chemical Engineering Science Div. Oct 1989. 37p. (NISTIR–89/3926). Available from NTIS, PC A03/MF A01.

Described is an apparatus which can deliver uniform heat flux densities of up to 80 W/sq cm over an area 7.8 cm by 15.2 cm for use in measuring the heat transfer and pressure drop in thin (6 mm or less), compact heat exchangers. Helium gas at flow rates of 0 to 40 kg/h and pressures to 6.9 MPa (1000 psi) is the working fluid. The instrumentation used in the apparatus and the methods for analyzing the data is described. The apparatus will be used initially to test the performance of prototype cooling jackets for the engine struts of the National Aerospace Plane (NASP).

4205 Materials Testing

Refer also to citation(s) 25375, 25622, 25755, 25756, 25757, 25758, 25759, 25760, 25761, 25762, 25763, 25764, 25765, 25766, 25767, 25768, 25769, 25837, 25955, 25956, 25957, 25958, 25959, 25960, 25961, 25962, 25963, 25964, 25965, 25966, 25967, 25968, 25969, 25970, 26054, 26060, 26088, 26432

26412 (CEA-CONF–9868) **Principles and applications of multiplane pulsed eddy currents.** David, B.; Champonnois, F.; Joffre, F. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Technologie. 1989. 3p. (CONF-890478–: 12. world conference on non-destructive testing, Amsterdam (Netherlands), 23-28 Apr 1989). Order Number DE90762062. Available from NTIS (US Sales Only), PC A02/MF A01.

A pulsed device using eddy currents, producing 8 shape signals on the screen like a sine wave system, has been developed. The method has been applied to the well-known problem of defects in stainless claddings of PWR reactor vessels.

26413 (CEA-CONF–9870) **Increasing reliability of defect characterization on sg tubings using a combination of signal processing and expert system.** Benoist, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (FR). Dept. de Technologie); David, B.; Pigeon, M.; Morizet, P.; Gaillard, P. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Technologie. 1989. 6p. (CONF-890478–: 12. world conference on non-destructive testing, Amsterdam (Netherlands), 23-28 Apr 1989). Order Number DE90762059. Available from NTIS (US Sales Only), PC A02/MF A01.

An expert system is developed for automatic analysis of eddy current signals provided by the multifrequency control of steam generators tubing. This article describes on one hand the aim and the results of the elimination of pilgrim noise, on the other hand the expert system which uses signal analysis and signal processing in unison.

26414 (ENEA-RT-COMB–89-13) **Fabrication of the artificial reference defects for non-destructive testings of fabricated machine components and equipment.** Bonavero, G. ENEA, Saluggia (Italy). Dipt. Ciclo del Combustibile. Oct 1989. 13p. (RT/COMB–89-13). Order Number DE90764322. Available from NTIS (US Sales Only), PC A03/MF A01.

The creation of artificial defects is necessary for the calibration of instruments and electronic equipment used in non-destructive testing (NDT) techniques, in order to obtain a very accurate and precise control of fabricated machine components, mechanical equipment, etc. NDT techniques are used in several industrial sectors: chemical, mechanical, metallurgical, aeronautical and nautical. ENEA (Italian Commission for Alternative Energy Sources), in collaboration with CCE-EURATOM, has set up a laboratory for the production of artificial reference defects using special techniques which ensure very high precision and high reproducibility of fabrication. This paper describes three of these techniques, namely: microspark-erosion, micro punching and micro drilling.

26415 (ENEA-RT-TERM–89-01) **Technologies in support of industrial processes: Non-destructive testing, advanced measuring techniques, diagnosis and signal elaboration - R&D progress report.** Palazzi, G.; Savelli, D. ENEA, Casaccia (Italy).

Dipt. Reattori Termici. Jul 1989. 148p. (In Italian). (RT/TERM–89-1). Order Number DE90764321. Available from NTIS (US Sales Only), PC A07/MF A01.

Control and measuring techniques applied to industry have the common aim of increasing safety, reliability and plant availability. The industrial monitoring system needs a lot of sensors, whose signals, elaborated and interpreted, allow one to define the best working condition; moreover, control instruments perform a diagnosis related to damages and breakages. The ENEA's (Italian Commission for Alternative Energy Sources) Thermal Reactor Dept. has developed sensors and measuring apparatus and has acquired advanced control techniques. All these systems, containing an original software, have been applied to industrial process problems and/or to experimental facilities both to increase reliability and to understand better process physics. Division activities are grouped in four sectors: (1) non-destructive examinations (ultrasonic, eddy current, thermography, holographic interpherometry, penetrant liquids and magnetoscopy); (2) innovative sensors (heated thermocouples, optical fiber sensors); (3) advanced measuring systems (laser technology for fluidodynamic measures, nuclear radiation techniques, infrared measuring, mass spectrometer, hot-film anemometer, chromatographic apparatus); (4) advanced technologies for diagnosis and signal analysis (digital image processing, statistical analysis).

26416 (KAERI/RR–754/88) **Study on eddy current technique for detection of defects in steam generator tubing in nuclear power plant.** Park, Day Young (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Cheong, Yong Moo; Chang, Ki Ok; Chung, Tae Eon; Park, Jong Hyun; Choi, Myung Sik; Ahn, Byeong Wan. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1989. 153p. (In Korean). Order Number DE90623234. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Defects in a steam generator tubings are one of the major problems in operation of a nuclear power plant. Eddy current multifrequency technique has been used for evaluation of the various type of defects, which is not sufficient to solve the problems. Failure of the tubings near the tubesheet, defects in the free length region due to pitting, and the defects due to fretting wear in anti-vibration bar, have been difficult problems in detection and quantitative analysis. In this research, various artificial defects were machined on the steam generator tubings, with electro-discharge machining technique. Combining the defects to the simulated tubesheet or support plate, detectability and ability to eliminate the tubesheet signal were investigated using frequency mixing technique. The effect on the tubesheet in multi-frequency method was studied. The results were analyzed with the interaction terms of the mixed frequency signals. By measuring the smallest detectable defects, it will be used as a basis for the eddy current technique of detection and evaluation of the flaws due to the pitting in Kori Unit 1. The results on the effect of the support plate or subesheet are directly related to the flaws on the top of the tubesheet in Kori Unit 2. (Author).

26417 (ZfK–637) **Positron annihilation studies of neutron irradiated reactor pressure vessel steels.** Brauer, G. (Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic)); Liszkay, L.; Molnar, B. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 15p. (CONF-8805223–: 20. Polish seminar on positron annihilation, Piechowice (Poland), 15-21 May 1988). Order Number DE90623235. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Several annealing studies by positron annihilation (Doppler broadening, lifetime) on neutron irradiated Cr-Mo-V reactor pressure vessel steels (Soviet type 15Kh2MFA) regarding the influences of irradiation temperature, fluence of fast neutrons as well as different impurity contents are presented and discussed. A possibility of explaining the positron annihilation data by irradiation induced carbide formation is proposed. (author).

4210 Combustion Systems

Refer also to citation(s) 25375

4220 Mining and Underground Engineering

26418 (KIB-RUB-TWM–89-3) **Ground deformations and strains when ground replacing processes of micro tunneling in noncohesive grounds are used.** Moellers, K. Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau. Mar 1989. 203p. (In German). Available from Copy held by UB/TIB Hannover.

The study deals with ground deformations and strains when ground replacing processes of micro tunnelling in non-cohesive grounds are used. Theoretical and experimental examinations are carried out regarding type, form and extent of a developing plastic ground zone, the ground strains in the surroundings of the replacing body as well as possible ground deformations at the upper edge of the terrain. With the aid of the examination results the possibilities of using ground replacing processes of micro tunnelling in non-cohesive grounds can be assessed in consideration of the local conditions. (orig.).

4230 Marine Engineering

Refer also to citation(s) 25449

26419 (IFP–37-268) **Skin friction of piles in sand. Influence of sand compressibility and tip shape.** Sid-Ahmed, R. Institut Francais du Petrole (IFP), 92 - Rueil-Malmaison (France); Nantes Univ., 44 (France); Ecole Nationale Superieure de Mecanique, 44 - Nantes (France). 1989. 195p. (In French). Order Number DE90770664. Available from NTIS (US Sales Only), PC A09/MF A01.

Calcareous sands encountered in many zones of petroleum activity often cause difficult problems in the design and installation of foundation piles. Skin friction mobilized by piles driven into compressible calcareous sands is very low, often negligible. Drilled and grouted piles represent an interesting alternative technique but with a much higher realization cost. The work, essentially experimental, deals with the analysis of the influence of calcareous sand characteristics upon the skin friction of driven piles or grouted piles. Different types of laboratory tests were carried out in a pressure tank, calibration chamber and using a bidimensional model. The results show: . the non uniformity of skin friction along a driven pile; being greatest at the tip, with the skin friction dependent upon the tip shape, . the preponderant influence of sand compressibility on horizontal stresses. The coefficient of lateral earth pressure decreases when sand compressibility increases. . the skin friction mobilized by drilled and grouted piles essentially depends on the shape (angularity) and the size of the sand grains as well as the roughness of the grout sheath.

4260 Components, Electron Devices and Circuits

Refer also to citation(s) 25511, 25836, 25837, 26176, 26181, 26201, 26225, 26383, 26387, 26505, 26510, 26531, 26534, 26536

26420 (AD-A–215759/2/XAB) **Luminescence of lanthanides and actinides implanted into binary III-V semiconductors and AlGaAs. Doctoral thesis.** Pomrenke, G.S. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Dec 1989. 319p. (AFIT/DS/ENP–89-4). Available from NTIS, PC A14/MF A02.

Through luminescence experiments it was observed that lanthanides, or rare earths, and also actinides, may be successfully introduced into binary and ternary III-V Group semiconductors. The study supports the feasibility of producing infrared light emitting diodes (LEDs) for the 0.9 to 1.7 micron spectral range. Besides systematic spectral characterization through photoluminescence, excitation mechanisms and decay kinetics were also investigated. Ytterbium (Yb), erbium (Er), thulium (Tm), praseodymium (Pr), and uranium (U) were successfully implanted into GaAs, InP, GaP, AlAs, or AlGaAs as observed through photoluminescence and also verified by secondary ion mass spectrometry (SIMS). The impurities were implanted through high (1 MeV), intermediate (380, 390 keV), and low (140 keV) energy standard and nonstandard implantation methods, followed by post-implantation annealing using both rapid thermal and conventional furnace annealing. Details on the

implantation techniques are given and implantation statistics were determined.

26421 (AD-A-215760/0/XAB) **Model of temperature effects in pulsed and continuous wave CO_2 lasers and optimization using response surface methodology. Master's thesis.** Melancon, T.B. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Dec 1989. 177p. (AFIT/GSO/ENP/ENS-89D-5). Available from NTIS, PC A09/MF A01.

The purpose of this study is to develop models of pulsed and continuous wave (CW) CO_2 lasers on a personal computer, and to explore optimization of the computed output power using response surface methodology (RSM). The first program is based on a four-level point model of pulsed CO_2 laser that predicts the temperature rise and the effects of temperature on the power, energy, and gain of the pulsed laser. The second program, derived from the first, is based on a four-level point model of a continuous wave CO_2 laser and calculates the power, gain, small-signal gain, and saturation flux of the CW laser. Both models were verified and extensively validated against published data with good results. Finally, this study explored the optimization of the CW laser model using RSM and found an operating point for maximum power at 10 torr and 4% CO_2. Several recommendations are included for upgrading the CO_2 laser models and continuing the optimization.

26422 (AD-A-215865/7/XAB) **Research on free electron lasers. Final report.** Colson, W.B. Berkeley Research Associates, Inc., CA (USA). 1989. 135p. (BRA-89-349R). Available from NTIS, PC A07/MF A01.

The research includes the derivation of better high-efficiency equations for describing the FEL in the strongly saturated regime. The equations retain much of the simplicity of the old theory, but are accurate for high-energy extraction. The dimensionless parameters of the equations are used to describe the LANL and LLNL FEL experiments. In a publication, the importance of the dimensionless current density j is emphasized for describing many diverse FEL physical effects. The effects of waveguides on the FEL radiation interaction are derived and presented in this report. The ELF FEL amplifier used a waveguide and is used as an example. It was found during the study that the gain spectrum of high-gain amplifiers like ELF can have sharp spikes. The spikes are not related to the use of a waveguide, but are an important result of this contract. A review paper invited by SPIE discusses some the techniques used to simulate FELs of many different kinds.

26423 (AD-A-215895/4/XAB) **State-to-state kinetics of XeCl*. Final report.** Kansas State Univ., Manhattan, KS (USA). Dept. of Chemistry. 27 Nov 1989. 10p. Available from NTIS, PC A02/MF A01.

The two- and three-body quenching of XeCl (B,C) by Xe and by mixtures of Xe with He, Ne, AR and KR have been measured at 300k. Three-body quenching leads to Xe Cl* formation. The relaxation processes of the six Xe (6P) states in Xe, Kr, Ar, Ne and He have been characterized at 300K. Experiments were done to characterize the quenching rate constants and the product states from the reactions of these Xe (6P) states with chlorine and fluorine containing molecules.

26424 (AD-A-215948/1/XAB) **Development of a superconducting six-axis accelerometer. Final report, 1 April 1985-31 March 1988.** Paik, H.J.; Parke, J.W.; Canavan, E.R. Anheuser-Busch, Inc., St. Louis, MO (USA). Jul 1989. 110p. Available from NTIS, PC A06/MF A01.

This report describes research on the superconducting six-axis accelerometer performed at the University of Maryland from April, 1985, to March,1988, under Air Force Contract F19628-85-K-0042. This report consists of four chapters. After an introduction and summary is given in Chapter 1, Chapter 2 discusses the theory of a superconducting six-axis accelerometer. The construction and test of the conducting six-axis accelerometer are given in Chapters 3 and 4, respectively. The superconducting six-axis accelerometer described in this report was invented to monitor the platform motions of a superconducting gravity gradiometer which is under development at the University of Maryland for space application. The signals from the accelerometer will be used to control the position and the attitude of the gradiometer platform. The superconducting six-axis accelerometer represents by itself a complete inertial navigation system. Integrated with the superconducting gravity gradiometer, it becomes a gradiometer-aided inertial navigation system.

26425 (AD-A-215988/7/XAB) **Carbon black-polyethylene composites for PTC (positive temperature coefficient) thermistor applications. Master's thesis.** Rohlfing, L.L. Pennsylvania State Univ., University Park, PA (USA). Davey Lab. Dec 1987. 110p. Available from NTIS, PC A06/MF A01.

A new class of composite Positive Temperature Coefficient (PT C) thermistors are commercially available. These composite thermistors exhibit a PTC measuring 6-8 orders of magnitude and have several advantages over conventional Barium Titanate 3 thermistors, including lower room temperature resistivity, better thermal shock resistance, and high temperature stability. In this study, composite PTC thermistors are produced from a carbon black/polyethylene composition that exhibited a PTC of resistance measuring 6-8 orders of magnitude at 125 C. The composites are irradiated (gamma source) to induce polymer crosslinking. Crosslinking imparts mechanical integrity and prevents the onset of an NTC effect above the transition temperature. Crosslinking stabilizes the high temperature resistivity to 200 C. The electrical properties of these crosslinked composites are examined as functions of temperature, frequency, and thermal cycling. To eliminate the crosslinking procedure, an insulating mullite phase was incorporated into the diphasic mixture to form a triphasic composite. Addition of the third filler yielded two effects. First, the filler provided sufficient mechanical stabilization of the composite structure to maintain high post-PTC resistance without an NTC effect. Second, the addition of an insulating filler resulted in a shift of the room temperature resistivity caused by a shift in the percolation curve.

26426 (AD-A-216008/3/XAB) **Gamma-ray laser project. Quarterly progress report, 1 July-30 September 1989.** Collins, C.B. Texas Univ., Richardson, TX (USA). Center for Quantum Electronics and Applications. Oct 1989. 55p. (UTD-GRL-8902). Available from NTIS, PC A04/MF A01.

Recent approaches to the problem of the gamma-ray laser have focused upon upconversion techniques in which metastable nuclei are pumped with long wavelength radiation. At the nuclear level the storage of energy can approach tera-Joules per liter for thousands of years. However, any plan to use such a resource for a gamma-ray laser poses problems of a broad interdisciplinary nature requiring the fusion of concepts taken from relatively unrelated field of physics. Our research group has described several means through which this energy might be coupled to the radiation fields with cross sections for stimulated emission that could reach 10 to the minus 17th power sq. cm. Such a stimulated release could lead to output powers as great as 3 X 10 to the 21st power Watts/liter. Since 1978 we have pursued an approach for the upconversion of longer wavelength radiation incident upon isomeric nuclear populations that can avoid many of the difficulties encountered with traditional concepts of single photon pumping. Recent experiments have confirmed the general theory and have indicated that a gamma-ray laser is feasible if the right combination of energy levels and branching ratios exists in some real material. Of the 1,886 distinguishable nuclear materials, the present state-of-the-art has been adequate to identify 29 first-class candidates, but further evaluation cannot proceed without remeasurements of nuclear properties with higher precision.

26427 (AD-A-216274/1/XAB) **Final report for NRL (Naval Research Laboratory) Contract N00014-87-C-2523.** Litton Systems, Inc., San Carlos, CA (USA). Electron Devices Div. 1 Apr 1989. 170p. Available from NTIS, PC A08/MF A01.

A small signal theory for the harmonic gyroklystron (HGK) has been developed. The theory uses approximate analytical solutions for the cavity fields of vaned magnetron-like cavities. A computer program called SSHGK has been written to calculate the small signal gain, resonant frequency, R/Q Q(0), and related quantities for a given set of cavity dimensions, beam parameters, magnetic field, and cavity loading. Program results indicate that there are broad ranges of input parameters which will produce acceptable small

signal gain at the second and third cyclotron harmonics. A representative design has been outlined for 35 GHz operation at the second cyclotron harmonic. An electron gun and magnetic focusing system has been designed to generate the required thin, hollow, axis encircling electron beam. This integrated gun and focusing system has been developed and modeled to easily generate the desired beam trajectories and cross section. This new design produces beams with high ratios of transverse to longitudinal momentum (alpha), and low velocity spreads required by gyroamplifiers such as the HGK. Using this design, a given gun structure can produce electron beams with adjustable alphas, beam radii, beam currents, annular widths, and velocity spreads just by changing the electrode voltages and magnetic field profile.

26428 (AD-A–216331/9/XAB) **Nd laser pumped by laser diodes. Professional paper.** Scheps, R. Naval Ocean Systems Center, San Diego, CA (USA). Aug 1989. 4p. Available from NTIS, PC A01/MF A01.

Pub. in Chemical Propulsion Information Agency Publication 492, Vol. 1, 171-172(Jun 1988).

Performance data for laser diode pumped cw Nd:BEL and Nd :YAG lasers are presented. Two phased laser diode arrays are used as the pump source, each emitting 500 mW. The heat sink for the arrays is temperature controlled to allow for wavelength tunability. A Nd:YAG rod was pumped under similiar conditions and the results are compared. Although the absorption bandwidth for Nd:BEL is substantially broader than for Nd:YAG, the Nd:BEL was found to have a higher threshold for lasing. Both rods had slope efficiencies of 42 percent. The dependence of the output mirror reflectivity was measured, with Nd:BEL showing a greater sensitivity to reflectivity than Nd:YAG. The optimum reflectivities were found to be .98 and .97 for Nd:BEL and Nd:YAG respectively. The maximum TEMOO cw power achieved for each rod at these reflectivities was 250 mW for Nd:BEL and 283 mW for Nd:YAG. We conclude that under the conditions used in this work, both BEL and YAG hosts perform comparably. Measurements of higher output power and efficiency have recently been made using two 1-watt single stripe laser diodes as the pump source, and these results are given as well.

26429 (AD-A–216376/4/XAB) **Numerical solution to the Boltzmann equation for use in calculating pumping rates in a CO_2 discharge laser. Master's thesis.** Honey, D.A. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Dec 1989. 131p. (AFIT/GEP/ENP–89D-5). Available from NTIS, PC A07/MF A01.

The collisional Boltzmann equation was solved numerically to obtain excitation rates for use in a CO_2 laser design program. The program was written in Microsoft QuickBasic for use on the IBM Personal Computer or equivalent. Program validation involved comparisons of computed transport coefficients with experimental data and previous theoretical work. Four different numerical algorithms were evaluated in terms of accuracy and efficiency. L-U decomposition was identified as the preferred approach. The calculated transport coefficients were found to agree with empirical data within one to five percent. The program was integrated into a CO_2 laser design program. Studies were then performed to evaluate the effects on predicted laser output power and energy density as parameters affecting electron kinetics were changed. Plotting routines were written for both programs.

26430 (AD-A–216398/8/XAB) **Experimental investigation of a chemical-laser-cavity flowfield. Master's thesis.** Stiglich, S.W. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Dec 1989. 122p. (AFIT/GAE/ENY–89D-36). Available from NTIS, PC A06/MF A01.

Chemical lasers require a cavity that establishes and maintains the proper gas dynamic properties during lasing. The design and performance of a flow system capable of supporting the hypersonic flow conditions in a lasing cavity are described. Using cold air as the working medium, the flow control system configuration and nozzle-cavity-supersonic diffuser assembly configuration were developed to establish acceptable flow conditions in the test section. Performance evaluation was based on pressure measurements in the nozzle-cavity-diffuser assembly and schlieren photographs of the flowfield in the cavity. Flow conditions in the test section were broken up into three different regions: flow in the hypersonic nozzles, flow in the base region and flow in the cavity region. Flow in the nozzles was analyzed using one-dimensional, steady, isentropic flow theory. Test results indicated that the hypersonic nozzles performed to design specifications. The Korst two-dimensional base-pressure flow model was used to describe the flow in the nozzle exit plane and base region. Experimentally calculated Mach numbers and static pressures corresponded very closely to theoretical values. Static pressure ports and schlieren photographs were used to describe the flow-field conditions in the cavity region. Pressure measurements indicated that supersonic conditions were reached in the cavity for specific supersonic diffuser throat areas settings, but conditions were short lived. Boundary layer, frictional, and three-dimensional effects were suspected as the main contributors to the flowfield degradation.

26431 (AD-A–216409/3/XAB) **C-w (continuous-wave) stimulated brillouin scattering of long-pulse chemical laser beams. Technical report.** Amimoto, S.T.; Hofland, R. Aerospace Corp., El Segundo, CA (USA). Laboratory Operations. 15 Nov 1989. 18p. (TR–0086A(2930-06)1). Available from NTIS, PC A03/MF A01.

Backward Stimulated Brillouin Scattering (SBS) is currently under consideration as a nonlinear optical process for passive phase conjugation (beam clean up) phase matching (beam combination), and pointing and tracking of continuous-wave (CW) HF chemical lasers for high power applications. Theoretical considerations indicate, however, that forward SBS processes dominate over backward SBS phenomena in the steady-state limit, so that SBS exhibits the desired properties (phase conjugation) only for short time periods. Since backward SBS thresholds for CW HF lasers are about 0.20 MW per spectral line, long-pulse laboratory chemical laser sources (PCLs) are needed to investigate small-angle forward scattering phenomena and the development of techniques for their suppression. The laser data presented herein suggest that a moderate-volume, photolysis-pumped PCL is a suitable source for the study of steady-state forward SBS processes and their suppression. In particular, low pressure PCLs can simulate CW HF-laser SBS behavior under conditions of the proper bandwidth, laser spectrum, SBS media effects, longitudinal mode structure, and other high-power HF laser characteristics.

26432 (CONF-891119–117) **Temperature dependence of the thermal conductivity of materials for microelectronic packaging: Measuring and modelling effects of microstructure and impurities.** Dinwiddie, R.B. (Oak Ridge National Lab., TN (USA)); Onn, D.G. Oak Ridge National Lab., TN (USA). [1989]. 12p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90009235. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The materials studied in this research, having a wide range of thermal conductivities, permit a study of the mechanisms which affect their behavior. Data on the thermal conductivity of several substrate materials, over a wide temperature range, were analyzed using the Klemens model. Parameters in this model, which include crystallite size ad impurity concentration, are determined through a nonlinear least squares fitting routine. 8 refs., 6 figs., 1 tab.

26433 (CONF-8904275–, pp. 10, Paper 1) **Point defect engineering applied to shallow junction ULSI processing.** Rozgonyi, G.A. (North Carolina State Univ., Raleigh (USA)); Honeycutt, J.W. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

The authors describe how a simple qualitative understanding of the interfacial reactions occurring during typical ULSI processes for junction formation, dopant activation, and contact silicidation can be used to eliminate end-of-range interstitial dislocation loops and beneficially impact the diffusion of dopants. Following a brief discussion of the well-documented effects of oxidation and nitridation on extended defects and dopant diffusion, conditions for elimination of implantation-induced defects are specified. Cross-section and plan-view TEM along with angle lapping and chemical etching of

implanted and diffused junctions are presented to illustrate the application of point defect engineering to process technology. 38 refs., 8 figs., 2 tabs.

26434 (CONF-8904275–, pp. 15, Paper 18) **Focused ion beam induced deposition.** Melngailis, J. (Research Lab. of Electronics, Cambridge, MA (USA)); Blauner, P.G. Oak Ridge National Lab., TN (USA). 1989. From Symposium on ion beam processing of advanced electronic materials; San Diego, CA (USA); 25-27 Apr 1989. In *Ion beam processing of advanced electronic materials.* Order Number DE89017342. Available from NTIS, PC A17/MF A01.

Focused ion beam induced deposition is already in use commercially for the repair of clear defects in photomasks, where missing absorber is added. Research is being carried out to extend this technique to the repair of x-ray lithography masks and to the restructuring and repair of integrated circuits, particularly in the prototype phase. In this technique a local gas ambient is created, for example, by aiming a small nozzle at the surface. The gas molecules are thought to adsorb on the surface and to be broken up by the scanned focused ion beam. A deposit is formed with linewidth equal to the beam diameter which can be below 0.1 μm. At small beam diameters and low currents (50-100 pA) the time to deposit 1 μm^3 is in the vicinity of 10-20 sec. If the gas is a hydrocarbon, the deposit is largely carbon, which is useful for photomask repair. On the other hand, if the gas is a metal halide or a metal organic, the deposit is metallic. The deposits have substantial concentrations of impurities due to the atoms in the organometallic, to the ion species used, or to the ambient in the vacuum chamber. Thus the resistivities of the metal films deposited typically range from 150 to 1000 $\mu\Omega$cm which is usable for some repairs. (Pure metals have resistivities in the range 2.5 to 12 $\mu\Omega$cm). The authors have deposited gold from dimethyl gold hexafluoro acetyl-acetonate and have achieved linewidths down to 0.1 μm, patches of 1 μm thickness with steep side walls and in some cases, resistivities approaching the bulk value. Other workers have reported deposits of Al, W, Ta, and Cr. They will review previous work in the field and present some of these own current results. 37 refs., 8 figs., 4 tabs.

26435 (ENEA-RT-TIB–88-36) **Study of a 10-liter active volume, X-ray preionized XeCl discharge laser system.** Letardi, T.; Bollanti, S.; Di Lazzaro, P.; Flora, F.; Giordano, G.; Hermsen, T.; Zheng, C.E. ENEA, Frascati (Italy). Centro Ricerche Energia. Apr 1989. 10p. (CONF-8809123–3: International congress on optical science and engineering, Hamburg (Germany, F.R.), 13-23 Sep 1988; RT/TIB–88-36). Order Number DE90764299. Available from NTIS (US Sales Only), PC A02/MF A01.

Paper presented at the international congress on optical science and engineering (Hamburg, 19-23 Sep 1988).

Rare-gas-halide lasers are receiving increasing attention because their ultraviolet wavelength optical outputs have promising applications in several fields. In order to establish a technical base for high average power excimer laser systems, a 10 liter active volume avalanche discharge laser device was developed at ENEA (Italian Commission for Alternative Energy Sources) Frascati Research Center. This paper presents the results of measurements on the XeCl laser with an active volume of 10 liter both with and without X-ray preionization and using a unoptimized plane-plane optical cavity. The laser discharge performances were experimentally studied both for the spark gap switched discharge and for the resonant-charge-transfer-type excitation circuits. For the first pumping circuit with X-ray preionization, 11 J of laser energy was extracted from a unoptimized laser mixture at the pressure of 3 atm. For the second pumping circuit with X-ray triggering, the laser energy output was about one half of that for the first circuit. Finally, a laser output energy of about one J was obtained by using the second pumping circuit without X-ray triggering. Although the laser energy is lower by a factor about 10 compared to the case of the X-ray preionized discharge, it may present advantages due to its simpler structure.

26436 (ENEA-RT-TIB–88-37) **Large area X-ray preionizer for electric discharge lasers.** Letardi, T.; Di Lazzaro, P.; Giordano, G.; Zheng, C.E. ENEA, Frascati (Italy). Dipt. Tecnologie Intersettoriali di Base. Apr 1989. 13p. (RT/TIB–88-37). Order Number DE90764373. Available from NTIS (US Sales Only), PC A03/MF A01.

Submitted to Applied Phys. B.

This paper describes the developement of a large area pulsed x-ray source, with a two-plasma cathode, suitable for the preionization of large aperture discharge lasers. Compared to other x-ray preionization sources with cold cathodes, the compact, low divergence x-ray diode described here does not require a very high voltage in order to operate stably and meet the preionization requirement for pumping large volume, high energy RGH lasers. In this way, shielding problems are greatly reduced, allowing safer handling of the system. Experiments show that when the diode voltage is about 60 kV, a fairly homogeneous discharge can be stably obtained in a 10-liter active volume XeCl laser, pumped by a DC charged 0.64 microF commercial capacitor bank and switched by a multichanned spark gap switch. Using a non-optimized optical cavity consisting of an aluminium-coated flat mirror and an uncoated silica plate, over 10 J of a spatially uniform laser output energy with a pulse duration of about 130 ns (FWHM) was achieved from a 3 atm XeCl laser mixture under a very low DC charging voltage (about 70 kV). These results support the persuasion that a good energy extraction and efficiency can be obtained with a relatively low x-ray dosage, even in large volume systems.

26437 (ENEA-RT-TIB–88-38) **FEL gain in the pulsed regime: A comparison between numerical and analytical results.** Dattoli, G.; Renieri, A.; Torre, A.; Giannessi, L.; Hermsen, T.; Richetta, M. ENEA, Frascati (Italy). Centro Ricerche Energia. Apr 1989. 18p. (RT/TIB–88-38). Order Number DE90764300. Available from NTIS (US Sales Only), PC A03/MF A01.

Submitted to Nuovo Cimento D.

In this paper we present simple and general formulae for the FEL gain in the pulsed regime including both the longitudinal mode coupling and the lethargy effect. Such relations, obtained from a numerical integration of the pulse propagation equations, are then compared to similar expressions obtained analytically in the limiting case of the long bunch approximation and the agreement is shown to be excellent.

26438 (ENEA-RT-TIB–88-40) **Parametrizing the gain dependences in a single passage FEL operating with moderate current e-beams.** Dattoli, G.; Giannessi, L.; Torre, A.; Fang, H.; Caloi, R.; Richetta, M. ENEA, Casaccia (Italy). Dipt. Tecnologie Intersettoriali di Base; Rome Univ. (Italy). Dipt. di Fisica. Apr 1989. 27p. (CONF-880813–3: 9. international congress on thermal analysis (ICTA), Jerusalem (Israel), 21-25 Aug 1988; RT/TIB–88-40). Order Number DE90764301. Available from NTIS (US Sales Only), PC A03/MF A01.

Submitted at the 10th international free electron laser conference (Jerusalem, 29 Aug-2 Sep 1988).

During the pioneering days of the FEL (Free Electron Laser), the electron sources were provided by the already existing accelerators, adapted to FEL operation, but not specifically designed for it. The main drawback of these accelerators was the low current and, in some cases, the unideal beam qualities. The first generation FELs were therefore intrinsically limited in gain, which ranged around 10%. An impressive technological effort has been made to design accelerators dedicated to FEL operation and thus provide an e-beam with large peak and average currents and small energy spread and emittances. In this paper we analyze a FEL operating in the moderate gain regime (0<gain coefficient<10) and discuss the modification induced on the well-known antisymmetric gain formula by nonlinear contributions in the gain coefficient. The gain degradation due to e-beam energy spread and emittances are also included, as well as those due to finite electron pulse effects. Final comments on the attainable laser pulse length and bandwidth are also presented.

26439 (ENEA-RT-TIB–88-52) **Ensheng Fu lectures given at Frascati Energy Research Center (Italy, 7-8-12 Apr 1988): FEL research in China, transmission of submillimeter waves, Compton-type FEL.** Ensheng Fu. ENEA, Frascati (Italy). Centro Ricerche Energia. Sep 1989. 43p. (RT/TIB–88-52). Order Number DE90764302. Available from NTIS (US Sales Only), PC A03/MF A01.

Three topics discussed at the ENEA (Italian Commission for Alternative Energy Sources) Frascati Research Center (April 1988) were the following. (1) The present status of FEL research work in

China: an overview of FEL experiments and theoretical research work in several institutes is given. The preliminary experimental results of the Raman- and Compton-type FELs are reported and discussed. The research program proposed is briefly summarized. (2) Transmission of submillimeter waves in a metal light pipe: the transmissivity expression is developed. A comparison of the theoretical calculation with the data measured by the author and data published elsewhere is made. It is shown that the author's results are closer to the experimental values than the previously calculated theoretical values. (3) Experimental study of the Compton- type FEL: the initial results of the experimental study for the first Compton FEL in China are reported. The relativistic 22 MeV electron beam was injected from and RF linac into an $SmCo_5$ permanent undulator with a 3 cm period and total period number of 98. A free electron spontaneous radiation output, with an output power of about 0.57 mW at 10 microns, was obtained.

26440 (ENEA-RT-TIB–88-54) **Numerical analysis of a carbon dioxide SFUR laser.** Barbini, R.; Colao, F.; Petri, A. ENEA, Frascati (Italy). Centro Ricerche Energia. Sep 1989. 23p. (RT/TIB–88-54). Order Number DE90764305. Available from NTIS (US Sales Only), PC A03/MF A01.

Within the framework of the ENEA (Italian Commission for Alternative Energy Sources) project on optical and electro-optical technologies, a TEA carbon dioxide laser was developed based upon a Self Filtering Unstable Resonator (SFUR). It delivers high energies (about 4 J) in short pulses (80 nsec), is tunable over 64 lines, and can operate in single transverse and longitudinal mode, with low divergence (about 1 mrad full angle). This paper presents a new numerical code developed for analyzing the SFUR cavity. The experimental data relevant to the performance of this laser are compared with the simulated cavity resonant modes. The code will allow the study of a very wide class of resonators and is, therefore, a useful tool in designing a new laser cavity.

26441 (ENEA-RT-TIB–89-17) **Status of the work at Frascati on large aperture and high repetition rate excimer lasers.** Bollanti, S.; Di Lazzaro, P.; Dipace, A.; Flora, F.; Giordano, G.; Letardi, T.; Sabia, E.; Hermsen, T.; Zheng, C.E. ENEA, Frascati (Italy). Centro Ricerche Energia. Jul 1989. 16p. (CONF-8904242–5: International congress on optical science and engineering, Paris (France), 24-28 Apr 1989). Order Number DE90764307. Available from NTIS (US Sales Only), PC A03/MF A01.

Paper presented at the international congress on optical science and engineering (Paris, 24-28 Apr 1989).

Increasing interest has been shown in scaling excimer lasers to high average power either with a high energy per pulse or with a high repetition rate since their applications are very promising and attractive in several fields, such as materials processing, photochemistry and so on. In order to cover a broad range of applications, the work at the ENEA (Italian Commission for Alternative Energy Sources) Frascati laboratories has mainly been devoted to developing two different discharge-excited laser sources, one operating at approx. 10 J/pulse and a repetition rate of approx. 100 Hz, and the other at approx. 1 J/pulse and a repetition rate of approx. 1 kHz. As an intermediate step, two x-ray preionized XeCl laser discharge devices were studies: one device has a discharge volume of 10 liters (10x10x100 cubic meters) (Laser:L) with a longitudinal gas flow mode in the discharge region, while the other operates in a transverse gas flow mode with a discharge volume of 0.45 liters (3x3x50 cubic meters) (Laser:S). Some of the experimental results obtained with the two devices are described in this report.

26442 (ENEA-RT-TIB–89-18) **A long pulse TE carbon dioxide laser with a negative branch unstable resonator.** Barbini, R.; Colao, F.; D'Amato, F.; Giorgi, M.; Marchetti, S. ENEA, Frascati (Italy). Centro Ricerche Energia. Jul 1989. 13p. (RT/TIB–89-18). Order Number DE90764294. Available from NTIS (US Sales Only), PC A03/MF A01.

Submitted to Nuovo Cimento.

High power, narrow bandwidth, pulsed carbon dioxide laser sources are useful in many research areas, such as Doppler Lidars, plasma diagnostics, and high quality FIR radiation generation. Many efforts have been made to obtain such sources, often using stable or positive branch unstable resonators, and/or e-beams pre-ionization techniques. This paper describes the design, construction and performance of a reliable carbon dioxide laser source with a simple UV pre-ionization, and a negative branch unstable resonator. The carbon dioxide laser emits single line, single mode pulses with time length up to 3.6 micron-s andPpeak/Ptail ratio down to 1.4. The pulse energy is 1 J and the beam divergence is less than 0.5 mrad full angle. This laser source will be further developed to be used in the ENEA (Italian Commission for Alternative Energy Sources) Lidar facility for wind measurements.

26443 (ENEA-RT-TIB–89-21) **Progress in free electron lasers.** Renieri, A. ENEA, Frascati (Italy). Centro Ricerche Energia. Jul 1989. 21p. (CONF-890730–2: 19. international conference on phenomena in ionized gases (ICPIG-19), Belgrade (Yugoslavia), 10-14 Jul 1989; RT/TIB–89-21). Order Number DE90764290. Available from NTIS (US Sales Only), PC A03/MF A01.

Paper presented at the International conference on phenomena in ionized gases (Belgrade, 10-14 Jul 1989).

In this paper, the status and perspectives of FEL (Free Electron Laser), one of the most interesting and unconventional laser sources developed in these years, are presented. Attention is given to a description of FEL operating principles, gain and efficiency and applications. The reason for this interest is related to the peculiar features of this device, such as tunability and very high peak and average power output.

26444 (ENEA-RT-TIB–89-28) **Ion molecular films. Applications: 2 - laser active materials.** Baldacchini, G.; Montereali, R.M.; Scavardo do Carmo, L.C. ENEA, Frascati (Italy). Dipt. Tecnologie Intersettoriali di Base. Nov 1989. 18p. (RT/TIB–89-28). Order Number DE90764304. Available from NTIS (US Sales Only), PC A03/MF A01.

Submitted to Journal of Mathematical Physics.

The field of laser active materials has developed considerably in the last few years. Progresses in microelectronics and integrated optics has allowed the development of the compact semiconductor laser. Analogously, research is proposed on the production and characterization of several ionic molecular films and on their properties regarding their use as active media for dielectric integrated lasers. The motivation for this research is based on the deep knowledge already existent on crystal and glass doped vibronic lasers made of active luminescent impurities and colour centres, as well as the yet initial knowledge on production and characterization of the host pure and doped materials as films.

26445 (EPRI-EL–6765) **Advanced cable fault locator: Final report.** Steiner, J.P. (Purdue Univ., Lafayette, IN (USA)); Weeks, W.L. Electric Power Research Inst., Palo Alto, CA (USA); Purdue Univ., Lafayette, IN (USA). c Mar 1990. 121p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

It has been demonstrated that it is possible to utilize the electromagnetic transients generated by the faulting process itself to locate the fault site in typical Underground Residential Distribution cable. Successful tests were carried out on a full scale model underground test facility and on two operating utility underground distribution circuits. The fault location system differs from existing ones not only in the way it handles the transients but also by the fact that it requires no operator interpretation of the waveforms. A personal computer is made a part of the system and, in response to simple, usually single key strokes, the computer does all of the interpretations and calculations. In practice, the fault location process is divided into three main parts: (1) "Global Location" which gives the fault location relative to the nearest transformer; (2) "Precision Location" which gives the fault location relative to the end of the isolated faulty cable; and (3) "Tracer Location" which gives the fault location relative to a convenient reference point on the ground in the vicinity of the fault site. 85 refs., 85 figs.

26446 (SAND–88-3188) **The development of ultraviolet-ozone cleaning as a production process in the packaging of integrated circuits.** Garrett, S.E. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90007960. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Ultraviolet-ozone (UV-ozone) cleaning was implemented as a production process to improve the cleanliness of metallized ceramic parts before a hermetic solder-sealing operation. The UV-ozone cleaning was developed as an in-situ process that maintained a low moisture content in the sealed package. Sealing yields were improved by as much as 30% with this procedure. Seal quality and therefore, reliability, were also increased. Possible detrimental effects caused by UV-ozone cleaning were investigated. In particular, the possibility for silver from the silver-filled epoxy to electromigrate was studied. UV-ozone cleaning was not found to be a factor in this phenomena. Qualification lots were given Electrical, Group B, Group D, and Life Tests to determine if the UV-ozone cleaning had any detrimental effects on the parts' reliability. No detrimental effects were found on standard complementary metal oxide semiconductor technology integrated circuits. Some evidence has shown, however, that the memory retention of both large-scale integrated and discrete silicon nitride oxide semiconductor structures degrade(s) after UV-ozone cleaning. 6 refs., 8 figs., 2 tabs.

26447 (UCID–21936) **A correlation-spectral method for line detection on noisy data.** Lu, Shin-Yee; Dowla, F. Lawrence Livermore National Lab., CA (USA). Feb 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90007925. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Fourier angular features extracted by using a correlation-spectral method are applied to the detection of line patterns in noisy wake data. A large scale image is first segmented into fixed size windows. Angular features are then extracted in each window. Directionality in a window is indicated by the peaks in its feature set. The spurious horizontal and vertical directions caused by the nonperiodity of the pattern in a window can be reduced by removing the mean from the window before feature extraction. The result for wake detection shows good agreement with human visual detection. 4 refs., 11 figs., 1 tab.

26448 (UCID–21938) **UCD-LLNL-SNL TV link system proof-of-performance.** Dirks, D.H.; Baptista, J. Lawrence Livermore National Lab., CA (USA). Feb 1990. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90007923. Available from NTIS, PC A03/MF A01 - OSTI.

This report contains the results of proof-of-performance tests of the TV link from University of California at Davis (UCD) to Lawrence Livermore National Laboratory (LLNL) and Sandia National Laboratory (SNL). These tests involve the measurement of a calibrated test signal originating in the TV classrooms in Bainer Hall at the UCD campus and received at various locations at LLNL and SNL. Proof of the TV link from LLNL to UCD involves the measurement of a calibrated test signal originating at the University of Monitoring (UM) racks in B131, Room 1282B, and received at the Link 1B classroom, RM 1122, Bainer Hall, UCD. 37 figs.

26449 (UCRL–102248) **Progress in the material development of $LiCaAlF_6:Cr^{3+}$ laser crystals.** Shinn, M.D.; Chase, L.L.; Caird, J.A.; Payne, S.A.; Atherton, L.J.; Kway, W.L. Lawrence Livermore National Lab., CA (USA). Mar 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-900373–1: OSA topical meeting on advanced solid-state lasers, Salt Lake City, UT (USA), 5-7 Mar 1990). Order Number DE90009542. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

High Cr^{3+} doping levels, up to 8 mole percent, and low losses have been obtained with the tunable solid-state laser material $LiCaAlF_6:Cr^{3+}$ (Cr:LiCAF). Measurements and calculations show that high pumping and extraction efficiencies are possible with the improved material. 13 refs., 4 figs., 1 tab.

26450 (UCRL-ID–103234) **Grounding and noise coupling.** Gunn, R.C. Lawrence Livermore National Lab., CA (USA). 12 Mar 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010206. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Grounding and Noise Coupling explains the purpose and techniques of electrically grounding electrical equipment and instrumentation systems to minimize or eliminate coupling of electrical noise. It covers the purpose of grounding, the signals to be grounded, the factors that affect these signals, threats that exist on systems, and noise coupling mechanisms. 9 figs., 1 tab.

43 PARTICLE ACCELERATORS

26451 (DOE/ER/40150–126) **1988 linear accelerator conference proceedings.** . Southeastern Universities Research Association, Newport News, VA (USA). Continuous Electron Beam Accelerator Facility. Jun 1989. 718p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84ER40150. (CONF-881049–: 14. linear accelerator conference (LINAC-14), Newport News, VA (USA), 3-7 Oct 1988; CEBAF–89-001). Order Number DE90007862. Available from NTIS, PC A99/MF A01; OSTI; INIS; GPO Dep.

This report contains papers presented at the 1988 Linear Accelerator Conference. A few topics covered are beam dynamics; beam transport; superconducting components; free electron lasers; ion sources; and klystron research. (LSP)

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Refer also to citation(s) 26496

26452 (BNL–44403) **National Synchrotron Light Source guidelines for the conduct of operations.** Fewell, N. Brookhaven National Lab., Upton, NY (USA). Mar 1990. 41p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90009200. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report briefly discusses the following topics: NSLS operations organization and administration; shift routines and operating practices; NSLS control room activities; communications; control of on-shift training; investigation of abnormal events; notifications; control of equipment and system status; lock-out tagout; independent verification; logkeeping; shift turnover; required reading; shift orders; equipment operations guides; operator aid postings; and equipment labeling.

26453 **High power neutral beam systems.** Rawls, J.M. (General Atomics, San Diego, CA (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Spurred by the requirement to supply megawatts of power to heat magnetically confined plasmas to temperatures of interest for fusion research, a new class of low energy, high power accelerators termed neutral beam injectors has been developed. Industry has played an important role in building upon technology advances at the national laboratories to engineer neutral beam injectors to meet the needs of specific users. A brief retrospective of the field is presented, with emphasis upon one particular application, that of DIII-D, a large tokamak at General Atomics. In this instance, the role of industry has been especially extensive because the user/system integrator is itself an industrial concern. 4 refs., 7 figs., 2 tabs.

26454 **Inspection and test planning for production SSC dipole magnets.** Wiant, B. (Westinghouse Electric Corp., Orlando, FL (USA)); Brown, B. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

B. Wiant for the Westinghouse SSC Program Team. It is important that the inspections and tests performed during the manufacturing cycle of the SSC dipole magnets ensure performance, reliability and the lowest possible price to the customer. The degree of inspection and the level of testing can have a direct economical effect on the entire SCC magnet program. Therefore, careful planning for inspection and test must be done to ensure magnets that can be readily produce at reasonable costs. More importantly, the magnets must meet design requirements. How inspection planning helps achieve these goals is the subject of this paper. 2 figs.

26455 **Electrical measurements during magnet construction.** Sintchak, G. (Brookhaven National Lab., Upton, NY (USA));

Ganetis, G.; Cottingham, G. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Throughout the construction phase of the cold mass for SSC magnets, electrical tests are made to determine that no faults in the coil structure have developed. These tests include ones designed to measure turn-to-turn voltage hold-off, hypot tests to ground, coil resistance, and instrumentation checks. These various tests will be described and the test parameters that are used will be covered. 4 figs.

26456 Quench start localization in full-length SSC R and D dipoles. Devred, A.; Chapman, M.; Cortella, J.; Desportes, A.; Kaugerts, J.; Kirk, T.; Mirk, K.; Schermer, R.; Tompkins, J.C.; Turner, J. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). DOE Contract AC03-76SF00098. (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Full-length SSC R and D dipole magnets instrumented with 4 voltage taps on each turn of the inner quarter coils have been tested. these voltage taps enable (1) accurate location of the point at which the quenches start and (2) detailed studies of quench development in the coil. Attention here is focused on localizing the quench source. After recalling the basic mechanism of a quench (why it occurs and how it propagates), the method of quench origin analysis is described; the quench propagation velocity on the turn where the quench occurs is calculated, and the quench location is then verified by reiterating the analysis on the adjacent turns. Last, the velocity value, which appears to be higher than previous measured, is discussed. 12 refs., 6 figs., 4 tabs.

26457 A very large superconducting solenoid. Fast, R.W. (Fermi National Accelerator Lab., Batavia, IL (USA)); Grimson, J.H.; Kephart, R.D.; Krebs, H.J.; Stone, M.E.; Theriot, E.D.; Wands, R.H. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). DOE Contract AC02-76CH03000;AC02-89ER40486. (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

A detector utilizing a superconducting solenoid is being discussed for the Superconducting Super Collider (SSC). A useful field volume of 8 m diameter x 16 m length at 1.5-2 T is required. The magnet will have a stored energy of ~1.5 GJ at 2T. All particle physics calorimetry will be inside the bore of the solenoid such that there is no need for the coil and cryostat to be thin in radiation lengths. An iron yoke will reduce the excitation required and will provide muon identification and a redundant momentum measurement of the muons. The authors have developed a conceptual design to meet these requirements. The magnet will use a copper-stabilized Nb-Ti conductor sized for a cryostable pool boiling heat flux of ~0.025 W/cm^2. A thermosiphon from a storage vessel above the cryostat will be used to prevent bubble stagnation in the liquid helium bath. The operating current, current density, coil subdivision and dump resistor have been chosen to guarantee that the coil will be undamaged should a quench occur. The axial electromagnetic force will be reacted by metallic support links; the stainless steel coil case will support the radial force. The 5,000 metric tons of calorimetry will be supported from the iron yoke through a trussed cylindrical shell structure separate from the cryostat. The coil and case, radiation shield and stainless vacuum vessel would be fabricated and cryogenically tested as two 8-m sections. These would be lowered into the underground experimental hall and installed into the iron flux return yoke to provide the required 16-m length. 3 figs.

26458 An integrated 3D design, modeling and analysis resource for SSC detector systems. DiGiacomo, N.J.; Adams, T.; Anderson, M.K.; Davis, M.; Easom, B.; Gliozzi, J.; Hale, W.M.; Hupp, J.; Killian, K.; Krohn, M. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Integrated computer aided engineering and design (CAE/CAD) is having a significant impact on the way design, modeling and analysis is performed, from system concept exploration and definition through final design and integration. Experience with integrated CAE/CAD in high technology projects of scale and scope similar to SSC detectors leads them to propose an integrated computer-based design, modeling and analysis resource aimed specifically at SSC detector system development. The resource architecture emphasizes value-added contact with data and efficient design, modeling and analysis of components, sub-systems or systems with fidelity appropriate to the task. They begin with a general examination of the design, modeling and analysis cycle in high technology projects, emphasizing the transition from the classical islands of automation to the integrated CAE/CAD-based approach. They follow this with a discussion of lessons learned from various attempts to design and implement integrated CAE/CAD systems in scientific and engineering organizations. They then consider the requirements for design, modeling and analysis during SSC detector development, and describe an appropriate resource architecture. They close with a report on the status of the resource and present some results that are indicative of its performance. 10 refs., 7 figs.

26459 Silicon pin diode hybrid arrays for charged particle detection: Building blocks for vertex detectors at the SSC. Gaalema, S. (Hughes Aircraft Co., Carlsbad, CA (USA)); Kramer, G.; Shapiro, S.L.; Dunwoodie, W.; Arens, J.F.; Jernigan, G. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). DOE Contract AC03-76SF00515. (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Two-dimensional arrays of solid state detectors have long been used in visible and infrared systems. Hybrid arrays with separately optimized detector and readout substrates have been extensively developed for infrared sensors. The characteristics and use of these infrared readout chips with silicon PIN diode arrays produced by MICRON SEMICONDUCTOR for detecting high-energy particles are reported. Some of these arrays have been produced in formats as large as 512 x 512 pixels; others have been radiation hardened to total dose levels beyond 1 Mrad. Data generation rates of 380 megasamples/second have been achieved. Analog and digital signal transmission and processing techniques have also been developed to accept and reduce these high data rates. 9 refs., 16 figs., 2 tabs.

26460 Development of superconducting strand and cable with improved properties for use in SSC magnets. Scanlan, R.M. (Lawrence Berkeley Lab., CA (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The critical current requirement for the NbTi superconductor strand was set at 2,750 A/mm^2 (5 T, 4.2 K) in the SSC Conceptual Design, compared with a value of 1,800 A/mm^2 which was specified for the strand used in the Tevatron dipoles. In addition, a filament diameter of 5 μm, instead of the 9 μm diameter used in the Tevatron, was chosen to reduce field distortion at injection. In order to meet the requirements for field homogeneity, the dimensional requirements for both strand and cable were also tightened. The technical solutions employed to achieve these improved properties and the resulting specifications will be discussed. 9 refs.

26461 Elements of a specification for superconducting cable and why they are important for magnet construction. Greene, A.F. (Brookhaven National Lab., Upton, NY (USA)); Scanlan, R.M. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The purpose of this paper is to point out several features of the specification for SSC superconducting cable and its insulation that are important for fabrication of dipole magnet coils. Among these are the dimensions of the cable and insulation and their relevance for obtaining coils with appropriate overall dimensions. Other important cable properties are related to the twist direction of wire used to fabricate it and the opposite twist (or lay) direction of the cable. For some coils it is easier to work with cable of a particular lay direction. In conjunction with the ease of coil winding comes the requirement in the specification for superconducting cable which restricts the cable surface condition. The ease of winding coils is governed by the ability to bend and twist the cable at the coil ends

without having wires come out of place, possibly later leading to insulation damage and a turn-to-turn short. 5 refs., 11 figs., 1 tab.

26462 Quality control testing of cables for accelerator magnets. Garber, M. (Brookhaven National Lab., Upton, NY (USA)); Sampson, W.B. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

A large number of cables have been tested for the CBA, HERA, and SSC Projects. The short sample test procedures and apparatus are reviewed. A simple rule for estimating cable performance from measurements on strands taken from the cable is described. By using this rule of thumb cable vendors can make reliable estimates without having to invest in the substantial equipment required for full cable testing. Extracted strand tests should be checked periodically by full scale tests on complete cables. 13 refs., 5 figs., 1 tab.

26463 Innovations in the design of multifilamentary NbTi superconducting composites for the supercollider and other applications. Gregory, E. (Supercon Inc., Shrewsbury, MA (USA)); Kreilick, T.S.; Wong, J. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

In recent work it has been shown that strand and cable, meeting the SSC specifications can be made on a production scale. In addition, work has been carried out to develop finer filamentary materials with larger strand diameters and higher J_c's, capable of operating at higher fields. Some of the problems encountered and the solutions developed are discussed in an effort to illustrate to the accelerator magnet designers the properties of conductors that may be available in the near future. 25 refs., 4 figs.

26464 SSC refrigeration system design studies. McAshan, M.S. (Lawrence Berkeley Lab., CA (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The SSC's two collider storage rings are formed of some 10,000 superconducting magnets of many types, all of which must be maintained below the chosen operating temperature of 4.35 K under a wide variety of operating conditions. Thus an extensive cryogenic system is required. The ancestor of the SSC is the Tevatron and its magnets are cooled by immersion in subcooled helium, the so-called single-phase flow, which is cooled in turn by heat exchange with boiling helium. This is the fundamental magnet cooling scheme adopted for the SSC. A centralized cryogenic system does not meet the need of the SSC. Instead, a systems of units capable of independent operation, but interconnected for redundancy, more nearly matches the requirements. The present design of the SSC has ten cryogenic units, each just over 8 km in length, with an eleventh in the high energy booster ring of the injector. In this paper, the author reviews the basic requirements for the cryogenic system of the SSC and describes some of its fundamental features, with the understanding that much is left to be accomplished in working out the complete design. 4 refs., 1 fig., 5 tabs.

26465 Dynamic modeling and simulation of the superconducting super collider cryogenic helium system. Hartzog, D.G. (Air Products and Chemicals, Inc., Allentown, PA (USA)); Fox, V.G.; Mathias, P.M.; Nahmias, D.; McAshan, M.; Carcagno, R. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

To study the operation of the Superconducting Super Collider (SSC) cryogenic system during transient operating conditions, they have developed and programmed in FORTRAN, a time-dependent, nonlinear, homogeneous, lumped-parameter simulation model of the SSC cryogenic system. This dynamic simulator has a modular structure so that process flowsheet modifications can be easily accommodated with minimal recoding. It uses the LSODES integration package to advance the solution in time. For helium properties it uses Air Products implementation of the standard thermodynamic model developed by the NBS. Two additional simplified helium thermodynamic models developed by Air Products are available as options to reduce computation time. To facilitate the interpretation of output, they have linked the simulator to the speakeasy conversational language. The authors present a flowsheet of the process simulated, and the material and energy balances used in the engineering models. They then show simulation results for three transient operating scenarios: startup of the refrigeration system from standby to full load; the loss of 4K refrigeration caused by the tripping of one of two parallel compressors in a sector; and a full-field quench of a single magnet half-cell. They discuss the response of the fluid within the cryogenic circuits during these scenarios. 14 refs., 19 figs., 2 tabs.

26466 Tevatron operational experiences. Norris, B.L. (Fermi National Accelerator Lab., Batavia, IL (USA)); Theilacker, J.C. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Fermilabs superconducting accelerator, the Tevatron has been operational for nearly six years. The history of its operation is presented. Several long shutdowns for superconducting dipole repairs are discussed. The dominant factor influencing the repair was conductor motion which fatigued the cable in the magnet ends. Borescoping and x-raying techniques were used to determine which magnet ends required repair. Detailed downtime logs were kept for each of the running periods. A discussion of the sources of downtime and a comparison for different operating modes is presented. 6 refs., 6 figs., 2 tabs.

26467 Centrifugal pumps for the superconducting super collider. Swift, W. (Creare Inc., Hanover, NH (USA)); McCormick, J.A.; Stacy, W.D. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The current refrigeration system design for the SSC consists of multiple helium refrigerators and liquefiers, each servicing sectors of the SSC which are approximately 8.25 km in length. Within each cryogenic refrigeration sector, there are various requirements for the distribution of liquid and gaseous helium. The machines which are to provide this distributive function must be robust and highly reliable because of the expense, associated with system downtime. This paper presents the preliminary design of a centrifugal pump for the SSC refrigeration system. Operational and performance specifications are defined for the pumps based on SSC requirements. Trades between bearing support systems are reviewed and a design configuration is recommended. Performance models for the pumps are presented together with a discussion of how these models may be used in system studies. 6 refs., 7 figs., 3 tabs.

26468 Passive superconductor a viable method of controlling magnetization multipoles in the SSC dipole. Green, M.A. (Lawrence Berkeley Lab., CA (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). DOE Contract AC03-76SF00098. (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

At injection, the magnetization of the superconductor produces the dominant field error in the SSC dipole magnets. The field generated by magnetization currents in the superconductor is rich in higher symmetric multipoles (normal sextupole, normal decapole, and so on). Pieces of passive superconductor properly located within the bore of the dipole magnet can cancel the higher multipoles generated by the SSC dipole coils. The multipoles generated by the passive superconductor (predominantly sextupole and decapole) are controlled by the angular and radial location of the superconductor, the volume of superconductor, and the size of the superconducting filaments within the passive conductor. This paper will present the tolerances on each of these factors. The paper will show that multipole correction using passive superconductor is in general immune to the effects of temperature and magnetization decay due to flux creep, provided that dipole superconductor and the passive correction superconductor are properly specified. When combined with a lumped correction system, the passive superconductor can be a viable alternative to continuous correction coils within the SSC dipoles. 20 refs., 8 figs., 2 tabs.

26469 A new method to calculate conductor magnetization in accelerator dipoles. ter Avest, D. (Univ. of Twente (Netherlands)); van de Klundert, L.J.M. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

During the ramping of superconducting dipole magnets as used in particle accelerators as the proposed SSC or CERN-LHC, magnetization in the conductor will manifest itself, perturbing the field homogeneity of the dipole. A numerical method was developed that covers the calculation of magnetic field inside the conductors, keystoned cables, current redistribution due to the variation of magnetic field with time as well as the multipole distribution in the dipole. For the calculation of current redistribution in a cable a keystoned cable geometry has been assumed, although the method applies to any geometry. The model incorporates saturation in the cable. In the case of an unsaturated cable the current redistribution can be described completely analytically. Also the model allows the calculation of the interstrand coupling loss as a function of the time-varying magnetic field. Finally, field remanency due to persistent currents in the filaments is described. The model was converted into a computer code and applied to the design of a CERN-LHC 10T dipole magnet. A relation will be presented that describes the dependence of the multipole distribution on the time varying field as well as on a few material properties. Also the effect of persistent currents on the multipole distribution will be demonstrated. 6 refs., 8 figs., 2 tabs.

26470 On the development of a 1 meter twin aperture 10 T Nb_3Sn dipole model magnet for the CERN LHC. ten Kate, H.H.J. (Univ. of Twente (Netherlands)); van de Klundert, L.J.M.; Daum, C.; Hoogland, W.; Bode, H.; Roeterdink, T.A.; van Overbeeke, F.; Perin, R. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The possible realization of the new 16 TeV hadron collider LHC of CERN presupposes the availability of the techniques to construct 10 tesla twin aperture dipole magnets either by using conventional NbTi magnet technology at 1.8 K or by using a Nb_3Sn conductor at 4.2 K. At present both alternatives are under development at CERN in collaboration with European laboratories and industries. A new initiative to explore the Nb_3Sn route was started recently in the Netherlands by the Applied Superconductivity Center at the University of Twente and NIKHEF, the National Institute for Nuclear and High Energy Physics. A 4 years R and D program was started to design and to manufacture a 1 meter Nb_3Sn dipole model magnet in collaboration with other research institutes and companies in the Netherlands. The magnet now under development will be the first one meter Nb_3Sn LHC dipole model magnet with a twin aperture designed for use at a nominal field of 10 T. The paper reports on general aspects of the design of the magnet and the present state of the developments. 18 refs., 5 figs., 3 tabs.

26471 Analytical solutions to SSC coil end design. Bossert, R.C. (Fermi National Accelerator Lab., Batavia, IL (USA)); Brandt, J.S.; Carson, J.A.; Fulton, H.J.; Lee, G.C.; Cook, J.M. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

As part of the SSC magnet effort, Fermilab will build and test a series of one meter model SSC magnets. The coils in these magnets will be constructed with several different end configurations. These end designs must satisfy both mechanical and magnetic criteria. Only the mechanical problem will be addressed. Solutions will attempt to minimize stresses and provide internal support for the cable. Different end designs will be compared in an attempt to determine which is most appropriate for the SSC dipole. The mathematics required to create each end configuration will be described. The computer aided design, programming and machine technology needed to make the parts will be reviewed. 2 refs., 10 figs., 1 tab.

26472 Straight ends for superconducting dipole magnet using constant perimeter geometry. Royet, J. (Lawrence Berkeley Lab., CA (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). DOE Contract AC03-76SF00098. (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The ends of the SSC Dipole magnets are a very critical aspect of the superconducting cable windings needed for this large project. The internal coils, where the radius at the pole is as small as 3/10 of an inch for the first turn, are difficult to form with the very stiff cable, and a high tension is needed. The curing operation on the coils is performed in a heated forming press which applies an important additional stress on the superconducting wire and insulation. A new design of this sensitive region of the magnets was performed at LBL, and several prototypes were built and tested. In this paper the construction method used to solve some of the most critical problems is exposed along with a description of the experimental work in progress. 3 refs., 2 figs.

26473 Coil measurement data acquisition and curing press control system for SSC dipole magnet coils. Dickey, C.E. (Fermi National Accelerator Lab., Batavia, IL (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

A coil matching program, similar in theory to the methods used to match Tevatron coils, is being developed at Fermilab. Modulus of elasticity and absolute coil size will be determined at 18-inch intervals along the coils while in the coil curing press immediately following the curing process. A data acquisition system is under construction to automatically acquire and manage the large quantities of data that result. Data files will be transferred to Fermilabs VAX Cluster for long term storage and actual coil matching. The data acquisition system will also provide the control algorithm for the curing press hydraulic system. A description of the SSC Curing Press Data Acquisition and Controls System will be reported. 20 figs.

26474 Superconductivity and the magnetic electron bond. Szurek, P. (Sentek, Novi, MI (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The concept of the magnetic electron bond as the fundamental characteristic of superconductivity was first introduced during a presentation at the 1988 Winter Annual Meeting of the American Society of Mechanical Engineers. Postulates describing the role of the electron and the magnetic bond were suggested to explain in a consistent manner known observations. What may becoming clear is that a boundary set of conditions may exist above and below the transition temperature at which a material superconducts. Prior to recent history, scientists have concentrated on postulating, experimenting, and learning about the set of conditions that exist above the transition temperature, which has set the standard for todays quantum theory. Above the transition temperature they have learned about the interrelationships that exist between the electron, a small magnetic and negatively charged body, and the nucleus, a large positively charged body. By grouping common general characteristics due to the interaction between the outer shell electrons and the nucleus of different elements, three bond types have been established, covalent, ionic, and metallic. They may now be in the process of determining those conditions that lie below the transition temperature, a realm where charge effects may no longer dominate magnetic effects. This may involve updating the quantum theory to reflect those conditions that exist above and below the transition temperature. The following discussion reviews, updates, and attempts to answer some preliminary questions regarding postulates that may define some of the conditions that lie below the transition temperature. As an introduction, figure 1 depicts what may occur to loosely held outer shell electrons below the transition temperature due to increased inner electron shielding. 7 refs., 9 figs.

26475 Status of tests of double-sided solid state multistripe detectors. Skubic, P.L. (Univ. of Oklahoma, Norman (USA)); Kalbfleisch, G.R.; Lambrecht, M.A.; Wilburn, C.D. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Two double-sided multistripe silicon detectors purchased from Micron Semiconductor, Ltd. have been bench tested. The devices are 40 mm x 40 mm x 300 μm thick, with 40 stripes on each side, in directions orthogonal to each other. Interstripe resistances of 250 $\pm$ 100 kΩ were measured on the non-diode (ohmic) side when the detectors were fully depleted. A Sr^{90} source and charge sensitive amplifiers were used to measure charge correlations between orthogonal stripes on opposite sides of the detectors as a function of bias voltage. At a full depletion voltage of 42 V, the difference in pulse heights from opposite-side stripes gave a Gaussian distribution consistent with the amplifier noise, indicating that the detectors work well as two dimensional position sensitive devices. 5 refs., 6 figs.

26476 Amorphous silicon devices for high energy particle detection. Xi, J. (Glasstech Solar, Inc., Wheat Ridge, CO (USA)); Hollingsworth, R.E.; Madan, A.; Zhu, R.Y. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). DOE Contract AC05-88ER80644. (CONF-890270--: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Hydrogenated Amorphous Silicon (a-Si:H) p-i-n diodes with very thick intrinsic layers have been fabricated and tested to explore the feasibility of particle detection in an SSC environment. Diodes with a thickness up to 42 μm have been successfully fabricated on metal coated glass substrates. Direct single particle detection has been achieved for 122 keV gamma rays. A signal was obtained for 2.3 Mev beta rays which are minimum ionization particles. The devices were neutron irradiated with an integrated flux of $10^{14}/cm^2$, resulting in a minor sensitivity drop which was fully recoverable by thermal annealing. 9 refs., 9 figs., 2 tabs.

26477 A cryogenic test stand for full length SSC magnets with superfluid capability. Peterson, T.J. (Fermi National Accelerator Lab., Batavia, IL (USA)); Mazur, P.O. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270--: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The Fermilab Magnet Test Facility performs testing of the full scale SSC magnets on test stands capable of simulating the cryogenic environment of the SSC main ring. One of these test stands, Stand 5, also has the ability to operate the magnet under test at temperatures from 1.8K to 4.5K with either supercritical helium or subcooled liquid, providing at least 25 Watts of refrigeration. At least 50 g/s flow is available from 2.3K to 4.5K, whereas superfluid operation occurs with zero flow. Cooldown time from 4.5K to 1.8K is 1.5 hours. A maximum current capability of 10,000 amps is provided, as is instrumentation to monitor and control the cryogenic conditions. This paper describes the cryogenic design of this test stand. 8 refs., 6 figs.

26478 Fermilab R and D test facility for SSC magnets. Strait, J. (Fermi National Accelerator Lab., Batavia, IL (USA)); Bleadon, M.; Hanft, R.; Lamm, M.; McGuire, K.; Mantsch, P.; Mazur, P.O.; Orris, D.; Pachnik, J. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270--: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The test facility used for R and D testing of full scale development dipole magnets for the SSC is described. The Fermilab Magnet Test Facility, originally built for production testing of Tevatron magnets, has been substantially modified to allow testing also of SSC magnets. Two of the original six test stands have been rebuilt to accommodate testing of SSC magnets at pressures between 1.3 Atm and 4 Atm and at temperatures between 1.8 K and 4.8 K and the power system has been modified to allow operation to at least 8 kA. Recent magnets have been heavily instrumented with voltage taps to allow detailed study of quench location and propagation and with strain gage based stress, force and motion transducers. A data acquisition system has been built with a capacity to read from each SSC test stand up to 220 electrical quench signals, 32 dynamic pressure, temperature and mechanical transducer signals during quench and up to 200 high precision, low time resolution, pressure, temperature and mechanical transducer signals. The quench detection and protection systems is also described. 23 refs., 4 figs. 2 tabs.

26479 A novel calibration system for SSC electromagnetic calorimeters. Zhu, Renyuan (California Institute of Technology, Pasadena (USA)); Ma, Hong; Newman, H.; Hamm, R. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). DOE Contract AC03-88ER80674;AC03-81ER40050. (CONF-890270--: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

A fast effective calibration technique has been developed for future Superconducting Super Collider (SSC) calorimeters based upon the radiative capture of protons from a pulsed RadioFrequency Quadrupole (RFQ) accelerator in a fluoride target. The intense flux of low energy photons acts as a clean pulse generator calibration signal equivalent to 20 GeV or more. This calibration technique has been demonstrated with a bismuth germanate (BGO) detector array, as well as with several barium fluoride detector crystals, to provide a calibration accuracy of 0.5% within 2 minutes. The SSC calibration has resulted from the development of this novel technique by Caltech over the past 5 years for the L3 BGO electromagnetic calorimeter, which uses a lithium target for the production of 17.6 MeV low energy photons as a calibration source. Proven techniques have also been developed to provide an in situ calibration for all 11,000 BGO detector crystals, with an absolute accuracy of 0.8% obtainable in 1-2 hours. The results of two experimental tests using the AccSys RFQ accelerator are reported, as is the preliminary design of a small storage ring that can be used to compress the output beam pulse from the RFQ accelerator into a target beam pulse of 100 nsec or less. 14 refs., 14 figs., 10 tabs.

26480 Piping of SSC synchrotron radiation revisited. Jones, L.W. (Univ. of Michigan, Ann Arbor (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270--: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Synchrotron Radiation of 20 TeV protons at the design circulating current of the SSC dominates the refrigeration heat load of the 4.15 K cryogenic system. An earlier paper suggested that the synchrotron x-rays could be piped by total external reflection from polished metal surfaces to warm absorbers to relieve this heat load. Although the piping efficiency discussed earlier is now known to be unrealistic, it can be shown that significant power can be saved nonetheless on detailed consideration of a realistic lattice. Specifically, judiciously placed radiation absorbers could intercept much of the radiation. Four alternative schemes are discussed. 3 refs., 4 figs.

26481 Study of scintillating fibers for a high resolution time of flight system at the SSC. Kuhlen, M. (California Institute of Technology, Pasadena (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270--: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The authors are studying properties of plastic scintillating fibers with the aim of constructing a Time of Flight system with very good time resolution (50 psec) and with high spatial segmentation. Such a system could be valuable at the SSC for two applications: (1) as a component of a first level trigger allowing the fast computation of the number of charged tracks and (2) for separating multiple events from the same bunch crossing. It would also be a valuable device for particle identification at a B-meson factory. The status of the project is being presented. Good time resolution requires a short decay time and a high light yield for the scintillator. They have measured the decay times for different samples of scintillating fibers. Photodetectors with small transit time spread, e.g. fast photomultiplier tubes or microchannel plates, will be needed. 7 refs., 11 figs., 1 tab.

26482 Impact of superconductive magnets on accelerator facilities. Cheng, A.; Ridler, J. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270--: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

As accelerators have been pushed to higher and higher energies, their field requirements and, therefore, their power and cooling system requirements, have increased substantially. Superconductive magnets have an internal electrical resistance of zero

and, therefore, waste almost no energy in the form of heat emission. As a result, their use substantially reduces both the power and cooling system requirements of the facility and, therefore, reduces both its capital and operating costs. Experience at CEBAF and at Fermilab demonstrates the tremendous savings resulting from the use of superconductive, rather than conventional magnets and RF cavities. If conventional magnets were used to produce the 20TeV beam energies desired for the new Superconducting Super Collider, the costs would astronomical and the project would be economically, politically, as well as perhaps technologically, infeasible. It is only through the use of superconductive magnets that the desired beam energies can reasonably be achieved.

26483 A large superconducting detector magnet without an iron return path. Green, M.A. (Lawrence Berkeley Lab., CA (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). DOE Contract AC03-76SF00098. (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

This paper describes a detector magnet which returns flux between the coils rather than through an iron return path. This actively shielded, uniform field 2 T magnet can be fabricated in separate parts which can be manufactured on the SSC site. This magnet can be built so that central field is uniform enough to permit a TPC detector to be used without iron poles. The field outside of the coil can be made to fall of as R^{-N} power where N approaches 9. A major advantage of the magnet described in the paper is that there is no pole piece to block the particle jets emanating from the collision region in the forward and backward directions. Inexpensive materials such as earth and concrete can be used to provide the mass needed to analyze particles such as mu mesons. As a result, problems such as experimental hall subsidence can be reduced. Perhaps the cost of such an experiment can also be reduced. This type of magnet would require experimenters to rethink their experimental concepts. 8 refs., 5 figs., 2 tabs.

26484 Design and analysis of the SSC dipole magnet suspension system. Nicol, T.H. (Fermi National Accelerator Lab., Batavia, IL (USA)); Niemann, R.C.; Gonczy, J.D. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The design of the suspension system for Superconducting Super Collider (SSC) dipole magnets has been driven by rigorous thermal and structural requirements. The current system, design to meet those requirements, represents a significant departure from previous superconducting magnet suspension system designs. This paper will present a summary of the design and analysis of the vertical and lateral suspension as well as the axial anchor system employed in SSC dipole magnets. 5 refs., 9 figs., 4 tabs.

26485 SSC superconducting dipole magnet cryostat magnet cryostat model style B construction experience. Engler, N.H. (Fermi National Accelerator Lab., Batavia, IL (USA)); Bossert, R.C.; Carson, J.A.; Gonczy, J.D.; Larson, E.T.; Nicol, T.H.; Niemann, R.C.; Sorenson, D.; Zink, R. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

A program to upgrade the full scale SSC dipole magnet cryostat model function and assembly methods has resulted in a series of dipole magnets designated as style B construction. New design features and assembly techniques have produced a magnet and cryostat assembly that is the basis for Phase I of the SSC dipole magnet industrialization program. Details of the assembly program, assembly experience, and comparison to previous assembly experiences are presented. Improvements in magnet assembly techniques are also evaluated. 6 refs., 5 figs.

26486 A finite element analysis of an SSC dipole magnet (NC-9 cross-section). Chapman, M.S. (Lawrence Berkeley Lab., CA (USA)); Wands, R.H. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Finite element methods are used to calculate the mechanical behavior of an SSC superconducting dipole magnet under different loading conditions. A two-dimensional model of the NC-9 design (aluminum collars) has been developed and used to calculate the transverse deflections and stresses in the dipole after assembly of the magnet, cooldown to 4.2 K, and energization to 6.6 T. Verification of the results with experimental measurements and observations, and limitations of the analysis, are also discussed. 6 refs., 6 figs., 2 tabs.

26487 Design study on the superconducting dipole magnets with non-circular aperture coils in application to future colliders. Ishibashi, Kenji (Kyushu Univ., Fukuoka (Japan)); Katase, Akira; Hirabayashi, Hiromi. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

In the near future, superconducting magnets with a small beam aperture will be required for high energy proton colliders. These magnets are usually designed to have a circular coil aperture. Their coils have many wedges for the winding to arch over the aperture as a whole, and the wedges are used to reduce the higher multipole components in the magnetic field. In this paper, the structure of a non-circular aperture is introduced to remove the wedges from the coils. Two types of windings, eccentric and elliptic coils, are studied for use of Rutherford type cables. It is shown that these coils have inherent advantages in decreasing the higher multipole components. 11 refs., 3 figs., 5 tabs.

26488 A high resolution scintillating fiber gamma-ray telescope. Atac, M. (Univ. of California, Los Angeles (USA)); Cline, D.B.; Cheng, M.; Park, J.; Zhou, M.; Fenyves, E.J.; Chaney, R.C.; Hammack, H. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

A large variety of Compton and pair production gamma-ray telescopes using scintillator blocks coupled to vacuum photomultiplier tubes has been built earlier for space based experiments. In these telescopes the scintillator block dimensions were large thus limiting the angular accuracies and resolutions. Here the authors are presenting the design and major characteristics of a large area gamma-ray telescope with high angular and energy resolution for high energy accelerator experiments, using scintillating fibers and recently developed position sensitive photomultiplier tubes. 6 refs., 10 figs., 1 tab.

26489 SSC costs and plans for industrial involvement. Elioff, T. (Lawrence Berkeley Lab., CA (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The objective of this presentation is to indicate the potential role for industry in various areas of the SSC construction program. In order to accomplish this goal, the authors will review and utilize the projected construction cost estimates that were developed for the SSC Conceptual Design Report (CDR) of 1986. The CDR cost estimate was designed to be representative of SSC costs on a national average basis. Recently a specific site near Waxahachie, Texas has been selected by the Department of Energy (DOE). Most of the technical systems and components of the SSC are expected to be bid or purchased on a national basis, thus, their average costs will not be impacted significantly by the specific site. The costs of conventional systems (buildings and structures) are more likely to experience some change in cost detail due to the specifics of the geology and underground construction methods at the chosen site. These possible changes have not been fully evaluated; therefore, they will continue to use the CDR information as the best representation for relative component costs. 8 figs., 13 tabs.

26490 Model SSC dipole magnet cryostat assembly at Fermilab. Niemann, R.C. (Fermi National Accelerator Lab., Batavia, IL (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The Superconducting Super Collider (SSC) magnet development program includes the design, fabrication and testing of full length model dipole magnets. A result of the program has been the development of a magnet cryostat design. The cryostat subsystems consist of cold mass connection-slide, suspension, thermal shields, insulation, vacuum vessel and interconnections. Design details are presented along with model magnet production experience. 6 refs., 13 figs.

26491 Perspectives on SSC magnet technology transfer. Jarabak, A.J. (Westinghouse Electric Corp., Orlando, FL (USA)); McGuigan, A.W.; Schumacher, E.P. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The Superconducting Super Collider provides society and its technical community with many prime opportunities for technology transfer. It is clear that technologies such as superconductivity will impact on their nations economic future. This paper addresses technology transfer from an industrial perspective. Westinghouse experience in this area and how it relates to SSC is discussed. 4 figs.

4302 Beam Dynamics, Field Calculations, and Ion Optics

Refer also to citation(s) 26227, 27358

26492 (LBL–28644) **A continuous plasma final focus.** Whittum, D.H. Lawrence Berkeley Lab., CA (USA). Feb 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (LBL–27965-Rev.;CONF-900264–5: Topical conference on research trends in nonlinear and relativistic effects in plasmas. San Diego, CA (USA), 5-8 Feb 1990). Order Number DE90009199. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Scaling laws are set down for a plasma cell used for transport, focusing and current neutralization of fine, intense, relativistic electron beams. It is found that there exists a minimum beam spot size, $\sigma_{min} \sim \epsilon_n(I_A/\gamma I)^{1/2}$, in such a focusing system. Propagation issues, including channel formation, synchrotron radiation, beam ionization and instabilities, are discussed. Three numerical examples are considered. 38 refs., 2 figs., 1 tab.

26493 (UCID–21791-3) **Charged-particle Beam Research Program quarterly report, July–September 1989.** Lawrence Livermore National Lab., CA (USA). Nov 1989. 21p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. Order Number DE90007937. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report discusses the following on charged-particle beam research program: management and application; beam propagation theory and computations; accelerator theory; ATA operations supporting the CPB experimental program; multiple pulse propagation experiment; diagnostics development and handling; and compact accelerator technology development beam research program publications.

26494 (UCRL-ID–103333) **Proposal for FY86 Lawrence Livermore National Laboratory particle beam research.** Smith, A.C. Lawrence Livermore National Lab., CA (USA). 15 Mar 1990. 91p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. Order Number DE90007936. Available from NTIS, PC A05/MF A01 - OSTI.

This document represents a combination FY 85 annual report plus the FY 96 proposal for Charged Particle Beam (CPB) research by the Lawrence Livermore National Laboratory's (LLNL's) Beam Research Program. Our report on FY 85 activities focuses on a set of experiments in which the ATA electron beam was propagated through a 1-foot-diameter, 8.5-m-long tank at pressures ranging from the ion-focused regime up to 500 Torr of dry, synthetic air. Based on the optimistic results from this first set of experiments, we propose in FY 86 to extend the tank length to 20 m. We will operate ATA at higher beam current to improve our understanding of intra-accelerator transport physics and to resolve, to our satisfaction, lead pulse stability issues centering around the beam's robustness against the hose instability as a function of beam conditioning. We expect these experiments to yield a wealth of detailed experimental propagation data which will help us prepare for propagating the ATA beam into the open air, an event planned for the end of FY 86. The principal elements are ATA operating time, constructing a flexible lead pulse/conductivity channel tracking facility, and preparing the atmospheric air line for the open air propagation tests. We believe our plans reflect and intelligent and practical symbiotic relationship with SDIO-sponsored Free Electron Laser experiments, also planned on ATA for FY 86, but with very different electron beam current and emittance requirements.

26495 (UCRL-JC–103152) **EM computer model of the time dependent ATA injector voltage.** Boyd, J.K.; Brandon, S.T.; Caporaso, G.J.; Orzechowski, T. J.; Weir, J.T. Lawrence Livermore National Lab., CA (USA). 1 Mar 1990. 3p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-8909216–11: DARPA/SDIO service annual charged particle beam review, Monterey, CA (USA), 18-21 Sep 1989). Order Number DE90009004. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An acceptable beam initial condition is most easily generated for propagation experiments when the beam energy variation is as flat as possible. Small energy variation helps to suppress instabilities and minimize transport problems. The ATA injector determines the beginning beam energy variation from the stalk resistance and specification of the time dependence of the applied voltage. The injector emits a beam from a diode configured with two re-entrant stalks, driven by 10 gaps. Ideally the gaps are triggered with a time of flight delay. In order to study the injector behavior when ideal gap triggering is not realized or stalk resistance is varied, an electromagnetic PIC computer model has been used. 5 figs.

26496 Some comments on the use of supermirrors at the Institut Laue Langevin. Pynn, R. (Los Alamos National Lab., Los Alamos Neutron Scattering Center, Los Alamos, NM (US)). pp. 210 of Thin-film neutron optical devices: Mirrors, supermirrors, multilayer monochromators, polarizers, and beam guides. Majkrzak, C. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). (CONF-8808212–: Thin-film neutron optical devices: mirrors, supermirrors, multilayer monochromators, polarizers, and beam guides, San Diego, CA (USA), 16-17 Aug 1988).

In this article, the author describes a calculation of the properties of a straight supermirror guide. Details of the supermirror polarizing benders fabricated at the Institut Laue Langevin in Grenoble, France.

26497 X-ray scattering above 100KeV. Hastings, J.B. (Dept. Physics, Penn State Univ. PA (US)); Willis, R.F.; Morra, R.; d'Almeida, F.; Mankey, G.; Kief, M. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

Conventional x-ray scattering studies have been limited to photon energies (wavelengths) in the 5 to 20 KeV (approx. 2A to 0.5A) regime. With these energies absorption lengths limit the volume of illumination to the first tens of microns of samples. If it were possible to use x-rays of very high energies, true bulk (tens of millimeters) samples could be studied. The availability, intensity and resolution possible with high energies are discussed and their role in the expanding field of x-ray scattering presented.

26498 Instability of compensated beam-beam collisions. Rosenzweig, J.B. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510 (USA)); Autin, B.; Chen, P. *AIP Conference Proceedings (American Institute of Physics) (USA)*, 193(1): 324-339 (15 Oct 1989). DOE Contract W-31109-ENG-38;AC03-76SF00098;AC03-76SF00515. (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

The beam-beam disruption phenomena in linear colliders are analyzed with a goal to minimize the effects of beam-beam disruption. By lowering the amount of charge in each pulse, it is possible

to make the disruption parameter and the beamstrahlung parameter smaller than unity.(AIP)

4303 Auxiliaries and Components

Refer also to citation(s) 26516

26499 (BNL–52211) **Proceedings of the switched power workshop.** Fernow, R.C. (ed.). Brookhaven National Lab., Upton, NY (USA). [1988]. 275p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). Order Number DE90008712. Available from NTIS, PC A12/MF A01; OSTI; INIS; GPO Dep.

These proceedings contain most of the presentations given at a workshop on the current state of research in techniques for switched power acceleration. The proceedings are divided, as was the workshop itself, into two parts. Part 1, contains the latest results from a number of groups active in switched power research. The major topic here is a method for switching externally supplied power onto a transmission line. Advocates for vacuum photodiode switching, solid state switching, gas switching, and synthetic pulse generation are all presented. Other important areas of research described in this section concern: external electrical and laser pulsing systems; the properties of the created electromagnetic pulse; structures used for transporting the electromagnetic pulse to the region where the electron beam is located; and possible applications. Part 2 of the proceedings considers the problem of designing a high brightness electron gun using switched power as the power source. This is an important first step in demonstrating the usefulness of switched power techniques for accelerator physics. In addition such a gun could have immediate practical importance for advanced acceleration studies since the brightness could exceed that of present sources by several orders of magnitude. I would like to take this opportunity to thank Kathleen Tuohy and Patricia Tuttle for their assistance in organizing and running the workshop. Their tireless efforts contribute greatly to a very productive meeting.

26500 (DESY-SR–89-08) **The asymmetric wiggler at HASYLAB.** Pflueger, J. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.). Hamburger Synchrotronstrahlungslabor); Heintze, G. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.). Dec 1989. 23p. Available from Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.). Available from Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.).

An asymmetric wiggler for the production of intense circularly polarized X-rays has been designed and tested successfully at HASYLAB. The device has ten periods and a period length of 240 mm. The magnetic design, device parameters and the results of magnetic field measurements are described. In order to characterize the circular polarization of the emitted light, the results of an experiment using this device for spin dependent photoabsorption at the Gd and Pt L_3 edges in Gd metal and in an Pt Fe alloy are presented. (orig.).

26501 (KAERI/RR–748/88) **Development of a high current ion implanter.** Choi, Byung Ho (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Kang, Hee Dong; Kim, Wan; Jin, Jeong Tae; Oh, Byung Hoon. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 204p. (In Korean). Order Number DE90623227. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

Ion implantation technology is now an established part of semiconductor materials processing, but also receives increasing industrial attentions for engineering applications. Recent industrial applications of the high current ion beams, such as buried dielectric layer formation in silicon by oxygen ion implantation and surface modifications of the ferrous materials by nitrogen ion implantation, require very high implant doses in the range of $10^{17} \approx 10^{18}$ ions/cm^2 in view of the stoichiometric requirements. An ion implanter of the energy of 100 keV and current of about 100 mA compatible with high implant dose has been designed. The design is based on the experimental data of a DuoPIGatron source developed last year which has provided nitrogen ion current of about 100 mA, and construction experiences of the deuteron accelerator for D-T neutron generation. The details of the study are as follows: 1.Overall design of the ion implanter 2.Design of high current accelerator tube which is able to control the ion optical properties for the compensation of the space charge effect 3.Design of the magnetic quadrupole doublet for control of the beam size on the target 4.Design of the high beam power slit and of beam diagnostics system 5.Design of the 2-D rotational target turntable for the high density beam irradiation 6.Study on the high current beam transport system 7.Modification of the beam extraction system in the DuoPIGatron for improvement of ion beam current. Especially, the beam divergence duo to the space - charge effect during acceleration and transportation is surveyed, and the electrostatic suppression and the neutralization of space charges are suggested. (Author).

26502 (LBL–26028) **Advanced Light Source control system.** Magyary, S.; Chin, M.; Cork, C.; Fahmie, M.; Lancaster, H.; Molinari, P.; Ritchie, A.; Robb, A.; Timossi, C. Lawrence Berkeley Lab., CA (USA). Mar 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-890335–275: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989). Order Number DE90009063. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Advanced Light Source (ALS) is a third generation 1–2 GeV synchrotron radiation source designed to provide ports for 60 beamlines. It uses a 50 MeV electron linac and 1.5 GeV, 1 Hz, booster synchrotron for injection into a 1–2 GeV storage ring. Interesting control problems are created because of the need for dynamic closed beam orbit control to eliminate interaction between the ring tuning requirements and to minimize orbit shifts due to ground vibrations. The extremely signal sensitive nature of the experiments requires special attention to the sources of electrical noise. These requirements have led to a control system design which emphasizes connectivity at the accelerator equipment end and a large I/O bandwidth for closed loop system response. Not overlooked are user friendliness, operator response time, modeling, and expert system provisions. Portable consoles are used for local operation of machine equipment. Our solution is a massively parallel system with >120 Mbits/sec I/O bandwidth and >1500 Mips computing power. At the equipment level connections are made using over 600 powerful Intelligent Local Controllers (ILC-s) mounted in 3U size Eurocard slots using fiber-optic cables between rack locations. In the control room, personal computers control and display all machine variables at a 10 Hz rate including the scope signals which are collected though the control system. Commercially available software and industry standards are used extensively. Particular attention is paid to reliability, maintainability and upgradeability. 10 refs., 11 figs.

26503 (LBL–28395) **Understanding modern magnets through conformal mapping.** Halbach, K. Lawrence Berkeley Lab., CA (USA). Oct 1989. 36p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8910379–1: Bloch symposium, Stanford, CA (USA), 27 Oct 1989). Order Number DE90009050. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

I want to show with the help of a number of examples that conformal mapping is a unique and enormously powerful tool for thinking about, and solving, problems. Usually one has to write down only a few equations, and sometimes none at all! When I started getting involved in work for which conformal mapping seemed to be a powerful tool, I did not think that I would ever be able to use that technique successfully because it seemed to require a nearly encyclopedic memory, an impression that was strengthened when I saw K. Kober's Dictionary of Conformal Representations. This attitude changed when I started to realize that beyond the basics of the theory of a function of a complex variable, I needed to know only about a handful of conformal maps and procedures. Consequently, my second goal for this talk is to show that in most cases conformal mapping functions can be obtained by formulating the underlying physics appropriately. This means particularly that encyclopedic knowledge of conformal maps is not necessary for successful use of conformal mapping techniques. To demonstrate these facts I have chosen examples from an area of physics/engineering in which I am active, namely accelerator

physics. In order to do that successfully I start with a brief introduction into high energy charged particle storage ring technology, even though not all examples used in this paper to elucidate my points come directly from this particular field of accelerator technology.

26504 (RAL–89-122) **Samarium polarising filters at ISIS.** Mayers, J.; Hannon, A.C.; Williams, W.G. Rutherford Appleton Lab., Chilton (UK). Nov 1989. 22p. Order Number DE90623229. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The status of the programme to develop samarium resonance absorption neutron polarising filters at ISIS is summarised. The results of the most recent measurements of filter performance are described. Some suggestions are made for future development work and the results of calculations of the performance of a proposed chopper spectrometer, incorporating polarising filters are given. (author).

26505 (UCRL—101932) **Railgun performance with a two-stage light-gas gun injector.** Hawke, R.S. (Lawrence Livermore National Lab., CA (USA)); Susoeff, A.R.; Asay, J.R.; Hall, C.A.; Konrad, C.H.; Wellman, G.W.; Hickman, R.J.; Heath, W.A.; Martinez, J.R.; Sauve, J.L. Lawrence Livermore National Lab., CA (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9004136–8: 5. IEEE symposium on electromagnetic launch technology, Destin, FL (USA), 1-5 Apr 1990). Order Number DE90009183. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper summarizes the results obtained with the HELEOS railgun which uses a two-stage light-gas gun (2SLGG) as an πinjector. The high velocity 2SLGG injector preaccelerates projectiles up to ~8 km/s. The high injector velocity reduces the exposure duration of the railgun barrel to the passing high temperature plasma armature, thereby reducing the ablation subsequent armature growth. The 2SLGG also provide a column of cool, high pressure hydrogen gas to insulate the rails behind the projectile, thereby eliminating restrike. A means to form an armature behind the injected projectile has been developed. In preliminary tests, the third stage railgun has successfully increased the projectile velocity by 1.35 km/s. Extensive diagnostics have been used to determine the behavior of the armature and track the launcher's performance. In some cases, velocity increase in the railgun section have been achieved, which are in close agreement with theoretical predictions, whereas in other experiments deviations from theoretical have been observed. The reasons for and implications of these results will be addressed. Recent tests are reported. 15 refs., 6 figs., 1 tab.

4304 Storage Rings

Refer also to citation(s) 26294

26506 (LBL–28483) **On storage rings for short wavelength FELs.** Chattopadhyay, S. Lawrence Berkeley Lab., CA (USA). Jan 1990. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900140–16: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 15-19 Jan 1990). Order Number DE90009059. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Significant advances have been made recently in the understanding of FEL physics and the technology of associated systems. We have witnessed experimental successes in the operation of FELs from the far infrared to the visible and near UV. All of the basic physics of FELs, as advanced up to date, in the small and high gain regimes (including exponential growth from noise, optical guiding, etc.) have been proved experimentally in the near or far infrared. These successes motivate us to explore the design of FEL systems at even shorter wavelengths, in the UV, XUV and soft x-ray regions, assuming that the same physics remain valid at these wavelengths. This paper is concerned with issues in the physics and design of storage rings as drivers of short wavelength FELs. 10 refs., 4 figs., 1 tab.

26507 (OUP–90-03) **The FCMM, a Fastbus Control and Memory Module for readout of the DELPHI SAT track detector.** Wikne, J.C.; Skaali, B. Oslo Univ. (Norway). Fysisk Inst. Feb 1990. 84p. Order Number DE90623232. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The Small Angle Tagger (SAT) in the DELPHI experiment at CERN concists of detector units placed close to the beam on both sides of the interaction point. The track detector part of the SAT is built of Si-strip detectors where position can be measured to an accurancy of 1 mm in the radial direction. A specially developed Fastbus module for reading and front end buffering of the data from the track detector is decribed in the report. The description is intended as a complete technical manual for the module. 13 refs.; 27 figs.

44 INSTRUMENTATION

Refer also to citation(s) 26303

26508 (KCP–613-4074) **Analytical sciences.** Hickman, T. (ed.). Allied-Signal Aerospace Co., Kansas City, MO (USA). Kansas City Div. [1990]. 72p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00613. Order Number DE90007965. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The mission of the Analytical Sciences Department of the Kansas City Division of Allied-Signal Inc. is to provide chemical, physical, mechanical, and metallurgical analyses. Materials, processes, and products are tested both within the laboratory area and on-site. The laboratory area has over 38,600 square feet and over $8 million in equipment, most of which is research grade. The Analytical Sciences Department is composed of 78 people committed to providing quality results on schedule with optimum cost management. The department is organized onto four sections: Mechanical Analysis, Organic Chemistry, Inorganic Chemistry, and Product Diagnostics. For failure analysis, customers have found the stress analysis in the Mechanical Analysis section and the chemical/electron optical/surface analysis in the Product Diagnostics section particularly helpful. The purpose of this directory is to assist those who use the services provided by the Analytical Sciences Department. Several reference tables are given which provide analysis term definitions and show interrelationships and limits of analytical techniques. A special section has been added on sample preparation and preservation so that the customer can help ensure sample integrity. For analytical techniques not listed in the directory, the Analytical Sciences staff can either procure the needed services from outside laboratories or develop the methods in-house. The analytical services performed by the Analytical Sciences Department can be made available to private industry and federal agencies through the Department of Energy Work For Others Program. Information on this program can be obtained from John L. Bowers. 72 figs., 8 tabs.

4401 Radiation Instrumentation

Refer also to citation(s) 25581, 25782, 26458, 26459, 26475, 26476, 26479, 26481, 26483, 26488, 26507, 26530, 26535, 26557, 26653, 27054, 27187

26509 (AD-A–216267/5/XAB) **Evaluation of bubble dosimeter response to neutron radiation. Final report, 88-1989.** Reilly, E.J. Naval Academy, Annapolis, MD (USA). 7 Jul 1989. 80p. (USNA-TSPR–159). Available from NTIS, PC A05/MF A01.

Because of the growing concern over the consequences of neutron radiation, the U.S. Navy is seeking an enhanced capability of neutron dose measurement. Current dosimetry systems have highly non-linear responses, which can lead to under and over-response, depending on the neutron spectrum. The bubble dosimeter, which has recently been developed, appears to have strong potential because of its nearly linear energy response over a wide energy range. The bubble dosimeter is also capable of measuring smaller neutron doses than current devices. However, very little information is available on the performance of bubble dosimetry measurement systems. Using radiation sources at the Naval Academy, bubble dosimeters and spectrometers were irradiated under a variety of conditions. The sources used included Cf252, Pu-Be, and a 14 MeV neutron generator. Results were obtained on the rate of bubble growth, detector lifetime, statistical behavior, and usefulness as

a spectrometer. An evaluation of a computer enhanced optical system were also made between the bubble dosimeter and other currently accepted means of neutron dose measurement, such as the neutron rem-meter (A/N-PDR-70), NE-213, TEPC, TLD, and CR-39. The studies found that the bubble dosimeter maintains constant sensitivity over 21 use cycles. The bubble dosimeter shows promise for naval dosimetry applications.

26510 (BNL–52230) **Report of the fifth workshop on synchrotron x-ray lithography.** Williams, G.P. (Brookhaven National Lab., Upton, NY (USA)); Godel, J.B.; Brown, G.S.; Liebmann, W. Brookhaven National Lab., Upton, NY (USA). [1989]. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-891195–Summ.: 5. Brookhaven National Laboratory workshop on synchrotron x-ray lithography, Upton, NY (USA), 16-17 Nov 1989). Order Number DE90007903. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Semiconductors comprise a greater part of the United States economy than the aircraft, steel and automobile industries combined. In future the semiconductor manufacturing industry will be forced to switch away from present optical manufacturing methods in the early to mid 1990's. X-ray lithography has emerged as the leading contender for continuing production below the 0.4 micron level. Brookhaven National Laboratory began a series of workshops on x-ray lithography in 1986 to examine key issues and in particular to enable United States industry to take advantage of the technical base established in this field. Since accelerators provide the brightest sources for x-ray lithography, most of the research and development to date has taken place at large accelerator-based research centers such as Brookhaven, the University of Wisconsin and Stanford. The goals of this Fifth Brookhaven Workshop were to review progress and goals since the last workshop and to establish a blueprint for the future. The meeting focused on the "Exposure Tool," that is, a term defined as the source plus beamline and stepper. In order to assess the appropriateness of schedules for the development of this tool, other aspects of the required technology such as masks, resists and inspection and repair were also reviewed. To accomplish this, two working groups were set up, one to review the overall aspects of x-ray lithography and set a time frame, the other to focus on sources.

26511 (DOE/ER/40503–1) **Silicon drift-chamber studies for possible use at RHIC: [Progress report].** Humanic, T.J. Pittsburgh Univ., PA (USA). Dept. of Physics and Astronomy. 27 Feb 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER40503. Order Number DE90009505. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

It is proposed to continue the program now underway at the University of Pittsburgh to study the feasibility of using silicon drift-chambers as particle tracking devices at RHIC. We are currently testing a UA6-type detector obtained from BNL, and propose to also study a new device that will become available this year: a cylindrical geometry detector design for NA45 (CERN). This new detector will be produced at BNL and the MPI-Institute in Munich and will incorporate updated techniques which should result in a reliable device with improved performance over the UA6-type detector. The one-year budget for this proposal is $50,079. 28 refs., 2 figs.

26512 (DOE/ID/12584–61) **Calibration of alpha-track monitors for measurement of thoron.** Pearson, M.D. UNC Geotech, Grand Junction, CO (USA). Mar 1990. 21p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-86ID12584. (UNC/GJ–51(TMC)). Order Number DE90007945. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The US Department of Energy (DOE) Office of Remedial Action and Waste Technology established the Technical Measurements Center (TMC) at the DOE Grand Junction Projects Office (GJPO) to provide standardization, calibration, verification of data, quality assurance, and cost-effectiveness for environmental measurements associated with the various DOE remedial action programs. The GJPO Radon Laboratory has conducted a number of studies evaluating the precision and accuracy of alpha-track monitors for the measurement of airborne radon (Rn-222) concentration. These studies have demonstrated the usefulness of using alpha-track monitors to measure radon. Alpha-track devices have also been proposed for estimating concentrations of thoron (Rn-220). 9 refs., 7 figs., 4 tabs.

26513 (LAPP-EXP–89-04) **Dedicated scintillating crystals for neutrino and dark matter detection.** Gonzalez-Mestres, L. (Grenoble-1 Univ., 74 - Annecy (FR). Lab. de Physique des Particules); Perret-Gallix, D.; Jacquier, B.; Chaminade, J.P.; Garcia, A. Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. Mar 1989. 4p. (CONF-890199–: 24. Rencontre de Moriond on tests of fundamental laws in physics, Les Arcs (France), 21-28 Jan 1989). Order Number DE90762043. Available from NTIS (US Sales Only), PC A02/MF A01.

It was recently proposed to use scintillating crystals incorporating a large amount of ^{115}In for the detection of low-energy solar neutrinos through Raghavan's reaction. We report here on recent progress in feasibility studies, i.e. crystal growth of transparent undoped and doped single crystals of indium compounds. We also discuss some aspects related to the luminescence of scintillators at low temperature, in connection with the proposal to develop a luminescent bolometer for particle identification through the heat/light ratio.

26514 (LA-UR–90-782) **Principles of the radiosity method for canopy reflectance modeling.** Gerstl, S.A.W.; Borel, C.C. Los Alamos National Lab., NM (USA). Mar 1990. 4p. Sponsored by National Aeronautics and Space Administration. DOE Contract W-7405-ENG-36. (CONF-900567–3: 1990 international geoscience and remote sensing symposium, College Park, MD (USA), 20-24 May 1990). Order Number DE90008943. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The radiosity method is introduced to plant canopy reflectance modeling. We review the physics principles of the radiosity method which originates in thermal radiative transfer analyses when hot and cold surfaces are considered within a given enclosure. The radiosity equation, which is an energy balance equation for discrete surfaces, is described and contrasted with the radiative transfer equation, which is a volumetric energy balance equation. Comparing the strengths and weaknesses of the radiosity method and the radiative transfer method, we conclude that both methods are complementary to each other. Results of sample calculations are given for canopy models with up to 20,000 discrete leaves. 16 refs.

26515 (LA-UR–90-967) **Perimeter radiation monitors for the control and physical security of special nuclear materials.** Fehlau, P.E. Los Alamos National Lab., NM (USA). [1990]. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-9003121–1: Symposium on access security screening: challenges and solutions for the 1990s, New Orleans, LA (USA), 28-30 Mar 1990). Order Number DE90008922. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Perimeter radiation monitors are gamma-ray and neutron measurement systems that can provide timely notice of theft or diversion of special nuclear material (SNM). The monitors may be hand-held instruments operated by security inspectors or automatic pedestrian or vehicle monitors located in exit pathways. A monitor's performance depends on its design, the characteristics of SNM and the operating environment, and proper monitor calibration and maintenance. Goals of ASTM Subcommittee C26.12 are to describe monitoring technology, how to apply it, and how to test its performance. 3 refs., 6 figs.

26516 (LBL–27600) **Engineering for high heat loads on ALS [Advanced Light Source] beamlines.** DiGennaro, R.; Swain, T. Lawrence Berkeley Lab., CA (USA). Aug 1989. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-890802–26: 7. synchrotron radiation instrumentation (SRI) national conference, Berkeley, CA (USA), 6-10 Aug 1989). Order Number DE90009046. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discussed general thermal engineering problems and specific categories of thermal design issues for high photon flux beam lines at the LBL Advanced Light Source: thermal distortion of optical surfaces and elevated temperatures of thermal absorbers receiving synchrotron radiation. A generic design for water-cooled heat absorbers is described for use with ALS photon shutters, beam defining apertures, and heat absorbing masks. Also, results

of in- situ measurements of thermal distortion of a water-cooled mirror in a synchrotron radiation beam line are compared with calculated performance estimates. 17 refs., 2 figs.

26517 (LBL–28681) **Field profile tailoring in a-Si:H radiation detectors.** Fujieda, I. (Lawrence Berkeley Lab., CA (USA)); Cho, G.; Conti, M.; Drewery, J.; Kaplan, S.N.; Perez-Mendez, V.; Quershi, S.; Wildermuth, D.; Street, R.A. Lawrence Berkeley Lab., CA (USA). Mar 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900466–2: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90009208. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The capability of tailoring the field profile in reverse-biased a-Si:H diodes by doping and/or manipulating electrode shapes opens a way to many interesting device structures. Charge collection in a-Si:H radiation detectors is improved for high LET particle detection by inserting thin doped layers into the i-layer of the usual p-i-n diode. This buried p-i-n structure enables us to apply higher reverse-bias and the electric field is enhanced in the mid i-layer. Field profiles of the new structures are calculated and the improved charge collection process is discussed. Also discussed is the possibility of field profile tailoring by utilizing the fixed space charges in i-layers and/or manipulating electrode shapes of the reverse-biased p-i-n diodes. 10 refs., 7 figs.

26518 (MPI-PAE/Exp.El.–216) **'Iconic' tracking algorithms for high energy physics using the TRAX-I massively parallel processor.** Vestergombi, G. NA35 Collaboration. Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik. Nov 1989. 22p. (CONF-890415–: Conference on computing in high energy physics, Oxford (UK), 10-14 Apr 1989). Order Number DE90767654. Available from NTIS (US Sales Only), PC A03/MF A01.

TRAX-I, a cost-effective parallel microcomputer, applying Associative String Processor (ASP) architecture with 16 K parallel processing elements, is being built by Aspex Microsystems Ltd. (UK). When applied to the tracking problem of very complex events with several hundred tracks, the large number of processors allows one to dedicate one or more processors to each wire (in MWPC), each pixel (in digitized images from streamer chambers or other visual detectors), or each pad (in TPC) to perform very efficient pattern recognition. Some linear tracking algorithms based on this 'iconic' representation are presented. (orig.).

26519 (ORNL/FTR–3563) **[Testing of a CAMECA Ims -4f ion microscope/microprobe]: Foreign trip report, March 10–17, 1990.** Christie, W.H. Oak Ridge National Lab., TN (USA). 26 Mar 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008982. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Analytical Chemistry Division has ordered a CAMECA Ims-4f ion microscope/microprobe instrument. The traveler participated in running specification tests for the instrument that he had written. Authorization of shipment of the instrument to the ACD was contingent upon successful completion of these tests. The instrument was found to be capable of meeting the performance specifications — with two minor exceptions. One exception arose because software required to operate the isotope ratio measuring hardware did not arrive in France from its US supplier. Isotope ratio measurement is one of the simpler functions of this instrument and inability to test this feature was not deemed reason to halt shipment to the ACD.

26520 (OUP–89-24) **The design of a linear amplifier for very small DC-currents, called LASC.** Stroem, S.; Storruste, A. Oslo Univ. (Norway). Fysisk Inst. Dec 1989. 24p. Order Number DE90623295. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A linear amplifier for the monitoring of very small currents from a high pressure ionization chamber has been designed. In the traditional design of an ionization chamber current amplifier, selected semiconductors and resistors are chosen to measure the very small currents in question. As the leakage currents in these semiconductors are larger than the smallest currents to be measured, very sophisticated electronics must be employed to succeed with the design. In order to overcome this disadvantage, the reported design is based on the following basic features: A capacitor is charged by the chamber ion current during a fixed time period, without loading the amplifier input. The use of a peak detector makes bouncing of the time-lag relay contacts unimportant, and allows an analog-to-digital converter to store the voltage build-up in the capacitor as a digital value. The measuring range of the amplifier, 0.001 pA to 1000 pA, makes it suitable for measuring gamma radiation in the air, both under normal and abnormal conditions. The design of the amplifier is described and results from tests are presented. 6 refs.; 6 figs.; 3 tabs.

26521 (OUP–89-25) **A BASIC program for an IBM PC compatible computer for drawing the weak phase object contrast transfer function: CTF.BAS Ver 1.1.** Olsen, A.; Skjerpe, P. Oslo Univ. (Norway). Fysisk Inst. 1989. 13p. Order Number DE90623296. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This report describes a computer program which is useful in high resolution microscopy. The program is written in EBASIC and calculates the weak phase object contrast transfer function as function of instrumental and imaging parameters. The function is plotted on the PC graphics screen, and by a Print Screen command the function can be copied to the printer. The program runs on both the Hercules graphic card and the IBM CGA card. 2 figs.

26522 (PB–90-148735/XAB) **Evaluation of nuclear asphalt-content gauges. Final report.** . Missouri Highway and Transportation Dept., Jefferson City, MO (USA). Div. of Materials and Research. Mar 1989. 80p. (MCHRP–88-1). Available from NTIS, PC A05/MF A01.

The study evaluated the accuracy and precision of the Troxler, Model 3241-C, and CPN, Model AC-2, Nuclear Asphalt Content Gauges. To achieve precisions at plus or minus 0.15% 95% of the time, it was necessary to establish special procedures for making test samples, controlling environment, and calibration. Both gauges provided acceptable results utilizing a 3-point calibration. Their use in the field would be acceptable when the proper procedures are followed.

26523 (UCRL–100498-Rev.1) **Absolute multilayer characterization at high spatial resolution via real-time soft x-ray imaging: Revision 1.** Madison, L. Lawrence Livermore National Lab., CA (USA). Mar 1990. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9003115–1: National Society of Black Physicists annual meeting, Baton Rouge, LA (USA), 21-24 Mar 1990). Order Number DE90009181. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An imaging-based technique has been modeled for its suitability and performance in measuring the spatial distribution of the absolute soft x-ray characterization of flat multilayer mirrors. Such a technique, if implemented experimentally, is anticipated to have substantially higher throughput (wafers/day) than is possible from prevailing non-imaging means. 5 figs.

4402 Radiation Effects on Instrument Components, Instruments, or Electronic Systems

26524 (AD-A–215781/6/XAB) **Final report of work performed by KM Sciences on Contract N00014-87-C-2017. Final report.** . KM Sciences, Arlington, VA (USA). 1989. 11p. Available from NTIS, PC A03/MF A01.

During this reporting period, the contractor made many trips to the University of California at Davis in support of NRL's program of study of the effects of radiation on various types of advanced integrated circuits and integrated circuit test structures. Major results of this effort were the submission of a technical paper on the beam monitoring and dosimetry system and the completion and utilization of a beam chopper system on beam line no. 2. In connection with the operation of the beam chopper, it was found that the radiochromic dye film offered a unique opportunity to measure the beam profile with greater precision and speed than by previous methods. Hence, the contractor is developing a capability for scanning beam spots taken with radiochromic dye films.

26525 (AD-A–216101/6/XAB) **Overview of radiation-induced interface traps in MOS (metal-oxide semiconductor) structures.**

Final report, 74-88. Oldham, T.R.; McLean, F.B.; Boesch, H.E.; McGarrity, J.M. Harry Diamond Labs., Adelphi, MD (USA). Nov 1989. 37p. (HDL-TR–2163). Available from NTIS, PC A03/MF A01.

We focus on radiation-induced interface traps, describing first how they fit into the overall radiation response of metal-oxide semiconductor (MOS) structures. Detailed measurements of the time-, field-, and temperature-dependences of the buildup of radiation-induced interface traps indicate three processes by which the buildup occurs. The largest of these is the slow two-stage process described by McLean and coworkers, which is rate limited by the hopping transport of hydrogen ions. Two other faster processes also contribute small interface trap buildups in gate oxides. The processes seem to be controlled by hole transport to the Si/SiO2 interface and by neutral hydrogen diffusion, respectively. We also discuss several models which fall into three classes, corresponding roughly to the three processes observed experimentally. Other topics discussed briefly are dose dependence, field oxide effects, chemical and processing dependences, and scaling effects.

26526 (PB–90-858887/XAB) **Electromagnetic pulse (EMP): Phenomena, simulation, and hardening. June 1972-January 1990 (A Bibliography from the International Aerospace Abstracts data base). Report for June 1972-January 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 124p. Available from NTISPC N01/MF N01.

Supersedes PB–87-861126; U.S. sales only.

This bibliography contains citations concerning electromagnetic pulse (EMP) generation and propagation mechanisms. Interactions and coupling with various structures, aircraft, spacecraft, missiles, electronic components, electrical circuits, and antennas are described. Physical and computerized simulations of EMP, and of EMP environments and interactions are considered. EMP protection methods and devices, including hardening, shielding, and isolation are also presented. (This updated bibliography contains 274 citations, 33 of which are new entries to the previous edition.)

4404 Well Logging Instrumentation

Refer also to citation(s) 26282

4405 Thermal Instrumentation

Refer also to citation(s) 26221, 26844

26527 (RFP–4279) **A system to determine temperature dependence of calibrated helium leaks.** Abercrombie, K.R. Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant. 31 Dec 1989. 25p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-90DP62349. Order Number DE90007970. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes the system developed by the Physical Metrology Laboratory at Rockwell International's Rocky Flats Plant to determine the temperature dependence of calibrated helium leaks. 2 refs., 15 figs.

26528 (SAND–90-0737C) **In-situ permeable flow sensor.** Sandia National Labs., Albuquerque, NM (USA). [1990]. 2p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9003129–1: Conference on support for the U.S. environmental and waste management industry by the DOE, Los Alamos, NM (USA), 14 Mar 1990). Order Number DE90008806. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The In-situ Permeable Flow Sensor is a new type of implantable instrument under development at Sandia National Laboratories that uses thermal boundary layer pertubation techniques to rapidly determine the three-dimensional velocity vector of groundwater flow in soils or permeable geologic media. This sensor is based on the refinement of previous technology, the Convective Heat Flow Probe, developed for the scientific study of the flow of geothermal fluids in thermally active regions of the earth's crust. The Convective Heat Flow Probe was designed as a logging tool for use in open or uncased boreholes. The newer In-situ Permeable Flow Sensor is based on the same theoretical principles but is designed to be permanently buried at waste or cleanup sites where long term monitoring of groundwater flow is of interest. This instrument is sensitive to permeable flows as low as a few meters per year.

26529 ac calorimeter for measurements of adsorbed gases on metal films at ^{4}He temperatures. Kenny, T.W. (Department of Physics, University of California, Berkeley, CA (USA)); Richards, P.L. *Review of Scientific Instruments (USA),* 61(2): 822-829 (Feb 1990). DOE Contract AC03-76SF00098.

An analysis is presented of the performance of an ideal ac calorimeter limited only by thermodynamic noise. A calorimeter based on this analysis is described which is designed for studies of the heat capacity of monolayers and multilayers of atoms and molecules adsorbed on a variety of surfaces. The calorimeter consists of Ge:Ga thermometers and NiCr heaters mounted on one side of a sapphire substrate, with an evaporated film deposited on the other side. The calorimeter is mounted on a ^{4}He cold finger in a UHV system allowing heat capacity measurements down to 1.6 K. In order to verify the performance of the calorimeter, measurements have been made of the heat capacity of 25-μg samples of indium, and of submonolayer coverages of ^{4}He on sapphire. The measured sensitivity corresponds to $<10^{-2}$ monolayers of ^{4}He adsorbed on the surface of the calorimeter in the gas phase.

4406 Optical Instrumentation

Refer also to citation(s) 25511, 25802, 26511, 26516, 26576, 27220, 27221, 27288

26530 (DOE/DP/10741–1) **The investigation of multilayer x-ray reflectors as x-ray optical elements: Final report.** Knight, L.V. Brigham Young Univ., Provo, UT (USA). Dept. of Physics and Astronomy. 15 Dec 1989. 52p. Sponsored by U.S. DOE Defense Programs. DOE Contract AS03-88DP10741. Order Number DE90009044. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

At BYU, we have been involved in x-ray optics for several years. In the last several years the intensity of this effort has significantly increased. A review of this work is included in the previous report. The work done in the last phase of this work on multilayer x-ray mirrors focused on a code to predict the curvature of etched silicon wafers and a study of the development of an x-ray interferometer for plasma diagnostics. The work was also partially supported by the State of Utah under the Centers of Excellence program and the interferometer work was done in collaboration with MOXTEK, Inc., an x-ray optics company which received support for some of the work through The Department of Defense. 28 refs., 34 figs., 8 tabs.

26531 (DOE/FTR–90009147) **[Evaluation of manufacturing R&D relating to optics fabrication for a Laboratory Microfusion Facility]: Foreign trip report, January 28–February 2, 1990.** Marion, J.E.; Wallerstein, E.P. Los Alamos National Lab., NM (USA). 30 Mar 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009147. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The purpose of the trip was to evaluate manufacturing R&D relating to optics fabrication for a Laboratory Microfusion Facility. At Zeiss the travelers assessed the double sided membrane grinding and polishing capabilities. At Limeil, Nice and Matra, the travelers assessed the progress on replicated optics and on sol gel, high reflection coatings. 6 refs.

26532 (DP-MS–89-1) **Fiber optic void fraction sensor.** Reed, S.E.; Berthold, J.W. Westinghouse Savannah River Co., Aiken, SC (USA). [1989]. 23p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-8910213–2: LEOS '89 annual conference, Orlando, FL (USA), 15-16 Oct 1989). Order Number DE90009124. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Reliable and accurate sensors and instrumentation for void fraction measurements are not commercially available. We have developed a fiber optic method to make these measurements as a part of a three-phase program: proof of principle, design and fabrication, installation and use during a series of flow channel tests. This paper covers the design, testing, and results for this fiber optic void fraction probe, designed to measure the concentration of liquid water in the flow channel. 20 figs.

26533 (KAERI/RR–717/88) **Research on optical applications in nuclear industry.** Kim, Cheol Jung (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Shin, Jang Soo; Lee, Sang Mock; Baik, Sung Hoon; Kwon, Seong Ouk; Hong, Suc Kyoung; Kim, Duk Hyeon. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 135p. (In Korean). Order Number DE90623308. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The laser fluorometer developed in 1987 has been modified to compensate the inner filter and quenching effects. The signal processing electronic circuit was redesigned and a computer interface was introduced for data processing. It has been already used in routine chemical analysis in the chemical analysis division. Its application to uranium monitoring in conversion plant is being investigated. Also, we found that it can be used in trace analysis of samarium and europium with detection limit of 1 ppb and 0.1 ppb, respectively. The IRMPA/D process of CDF_3 and CHF_3 have been studied. The pressure effects of CDF_3,CHF_3 and added buffer gas were investigated. Mainly, the change in reaction rate was examined while varying the pressure of CDF_3, CHF_3 and buffer gas. The IRMPD reaction ratio of CDF_3 and CHF_3 from below 0.1 torr up to a few torr was studied and the buffer gas pressure effect was investigated at constant pressure of CDF_3 or CHF_3 of 1 torr. Several kinds of buffer gas, Ar, N_2, and SF_6, were used to investigate the buffer gas pressure effect. We applied double exposure holographic interferometry, and analyzed qualitatively the distortion due to thermal heat and vibration. The research on holographic remote inspection will be achieved to apply this technique to the nuclear fuel cycle facilities. (Author).

26534 (RFP–4247) **New laser measurement system for a Century-Detroit contour inspection gage.** Dutton, G.W. Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant. 31 Dec 1989. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-90DP62349. Order Number DE90007971. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Installation of a Hewlett-Packard Model 5501A Laser Measurement system on a computer-controlled contour inspection gage at Rocky Flats is described. Gage modification details are explained and comparisons are made with the inteferometer system originally incorporated on the gage. 1 ref., 7 figs.

26535 (UCID–21966) **Subkilovolt response of Kodak T max XUV film.** Dittmore, C. (Lawrence Livermore National Lab., CA (USA)); Stoering, J.P.; Gullikson, E. Lawrence Livermore National Lab., CA (USA). 8 Feb 1990. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90007926. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A calibration of Kodak T max 100 XUV film at six x-ray energies ranging from 0.27 keV to 1.49 keV has been concluded. The primary purpose was to compare the sensitivity of this film to that of Kodak type 101-07 XUV film in order to appraise the feasibility of replacing the type 101-07 film with the type T max 100 film. In addition to being considerably less expensive, the T max 100 film is less disposed to abrasion from handling. A secondary objective was to provide a base for further response measurements should the T max 100 film prove to be an acceptable substitute for the type 101-07 film. 10 figs., 2 tabs.

26536 (UCRL–102937) **Error correction of the DEA [Digital Electronic Automation] Coordinate Measuring Machines at LLNL.** Carter, D.L. Lawrence Livermore National Lab., CA (USA). 14 Nov 1989. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8911177–1: IMOG measurement and technology subgroup on seminar on coordinate measurement machine user, Livermore, CA (USA), 14-15 Nov 1989). Order Number DE90008913. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

LLNL uses Coordinate Measuring Machines (CMM) manufactured by Digital Electronic Automation, Inc. (DEA) to provide in-process and final measurements of various components as they are assembled and aligned for later experimentation. The machines achieve their accuracy by using real-time passive error compensation to correct for all 21 parametric error components. LLNL does its own parametric testing and downloading of error correction data into the CMM's computer. This paper describes the theory, the parametric tests, the data or "map," and the final checkout of the machines. 4 refs., 20 figs., 3 tabs.

26537 (UCRL-JC–103264) **Temperature Evaluated Mine Position Survey (TEMPS) application of dual-band infrared methodology.** Del Grande, N. Lawrence Livermore National Lab., CA (USA). Mar 1990. 20p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900396–3: IRIS Specialty Group meeting on passive sensors and atmospheric physics, Laurel, MD (USA), 13 Mar 1990). Order Number DE90009182. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We are investigating a temperature evaluated mine position survey (TEMPS) for remote detection of buried land mines. The TEMPS methodology uses two passive IR channels peaked near 5 and 10 microns to decouple temperature from emissivity related effects. The true (corrected) temperature maps show surface temperature variations of 0.2°C. Corrections are made for air-path interference and reflected sky radiation. We exploit a property of Planck's radiation law which applies for small temperature excursions from 288 K. The radiant emittance is proportional to emissivity times absolute temperature to the power of (50/wavelength in microns). Our corrected temperature maps show patterns of conducted heat generated by buried objects which heat and cool at different rates than the surrounding materials. These patterns are distinguished from the patterns produced by surface objects. Their respective spatial, spectral, thermal, emissivity and temporal signatures differ. EG & G flew a dual-band IR scanner at 60 m for our demonstration of the TEMPS methodology at Nellis AFB. We detected simulated mine targets covered by 10 cm of dry sand. Optimization of this technology is expected to enhance the capabilities of the military community for standoff mine detection and other applications. 9 refs., 11 figs., 1 tab.

4407 Geophysical and Meteorological Instrumentation

26538 (CONF-9005149–1) **An automated locating and data logging system for geophysical surveys.** Nyquist, J.E.; Blair, M.S. Oak Ridge National Lab., TN (USA). [1990]. 15p. Sponsored by Environmental Protection Agency. DOE Contract AC05-84OR21400. From 4. national outdoor action conference; Las Vegas, NV (USA); 14-17 May 1990. Order Number DE90008889. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Oak Ridge National Laboratory has developed an Ultrasonic Ranging and Data System (USRADS) and interfaced the system with a Geonics EM31 terrain conductivity meter. USRADS keeps track of a surveyor's position by measuring the time-of-flight of ultrasonic pulses from an transducer carried by the surveyor in a backpack to stationary receivers arrayed over the survey area. We surveyed a 13-acre landfill at Idaho National Engineering Laboratory with three people, in three days, collecting over 25,000 EM31 quadrature and imphase readings. USRADS offers several advantages over conventional EM31 surveys: (1) time and money are saved because it does not require a civil survey to lay a grid before the geophysical survey begins, (2) data are directly recorded by a portable computer and are available for analysis in the field, and (3) refining or expanding the grid about an anomaly does not require civil surveying to add extra grid points. USRADS can also be used with a gamma scintillometer for radiation surveys. Currently, we are working to interface USRADS with a portable x-ray fluorescence spectrometer for detecting heavy metals in soil. 5 refs., 8 figs.

4408 Miscellaneous Instrumentation

Refer also to citation(s) 25453, 25691, 26117, 26415, 26445, 26784, 26886

26539 (JINR–13-88-620) **On the role of secondary electrons in the low pressure arc discharge.** Lyatuszynski, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems); Yushkevich, Yu.V.; Maczka, D. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 6p. (In

Russian). Order Number DE90623307. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The ionization efficiency values for noble gases in plasma ion source of a mass-separator have been measured. The contribution of secondary electrons into total ion production has been estimated. For the argon-helium mixture this contribution is about 35%. 12 refs.; 4 figs.

26540 (NUREG/CR–5484) **pH sensors based on iridium oxide.** Tarlov, M.J. (National Inst. of Standards and Technology, Gaithersburg, MD (USA). Chemical Process Metrology Div.); Kreider, K.G.; Semancik, S.; Huang, P. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; National Inst. of Standards and Technology, Gaithersburg, MD (USA). Chemical Process Metrology Div. Mar 1990. 20p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

Results are presented on the pH-potential response of dc magnetron reactively sputtered iridium oxide films. The films exhibit a nearly Nernstian response to pH, no hysteresis effects, and minimal response to ionic interferences. Sensitivity to certain redox species is observed, however. In addition, methods are discussed for preparing model iridium oxide sensor surfaces for ultrahigh vacuum surface analytical studies. Stoichiometric IrO_2-like surfaces are shown to be relatively inert to gas phase water. However, hydroxylation of IrO_2-like surfaces can be induced by rf water plasma treatment. 17 refs., 5 figs.

26541 (SAND–89-0855) **Software to characterize tuning fork resonators used in the Quartz Ditigal Accelerometer.** Collins, C. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 46p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90007913. Available from NTIS, PC A03/MF A01 - OSTI.

This report documents the software developed to characterize tuning fork resonators used in the Quartz Digital Accelerometer. The results, after characterizing numerous resonators, indicate a resonant frequency sensitivity to input drive level. Also, the resonant frequency increased for some of the tuning fork resonators but decreased for others. The characterization process used to obtain these results is summarized. 4 refs., 14 figs.

26542 (SAND–89-1089) **Modeling elastomer displacements for tactile sensing applications.** Novak, J.L. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 34p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90007959. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Many capacitance-based tactile sensors measure the displacements of an elastic substrate at multiple sites. A large number of sensing applications, however, require knowledge of the surface forces. This report considers the problem of reconstructing these surface forces from the measured displacements. Two models for reconstruction are considered. Contacts in which the area is much smaller than the dimensions of the compliant surface are modelled using a linear elastic half-space. Analyses of the deformations using this model confirm a strong coupling between normal and tangential displacements for normal, tangential or arbitrary loads. Using a spatial frequency formulation, the minimum spatial sampling densities for reconstructing displacements (as a prerequisite to reconstructing forces) are shown to be significantly smaller than those required for reconstructing strains. The second model, the bonded spring, is introduced for surface contacts which extend over the entire sensor surface. A nonlinear stress-strain relationship is included since tactile sensors undergo relatively large deformations. An empirical relationship between elastic pad geometry and the effective modulus of elasticity is also presented. 22 refs., 5 figs., 1 tab.

26543 (UCRL–99806) **The design of an ultra-precision CNC measuring machine.** Thompson, D.C. Lawrence Livermore National Lab., CA (USA). [1989]. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8908220–1: 39. international Institution for Production Engineering Research general assembly, Trondheim (Norway), 20-26 Aug 1989). Order Number DE90009189. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A specialized ultra-precision CNC measuring machine is being developed to provide an inspection capability compatible with existing precision turning machines. The instrument is to be applied to the inspection of the inner and outer surfaces of hemispherical shells and other axisymmetric parts, with diameters of up to 400 mm. The overall accuracy of the machine operating in continuous path contouring mode is to be less than 0.75 micrometre (p-v) per surface, including both instrument and process-related errors. In addition, an accuracy of 1.75 micrometres is required for the inspection of wall thickness on some categories of parts, which in some instances may be distorted by gravity loading. This latter requirement dictates a single setup for the inspection of inner and outer surfaces, and effectively eliminates a standard Coordinate Measuring Machine (CMM) configuration for the new gauge. The new instrument is known as the Certification of Process (COP) Gauge. 9 refs., 5 figs., 2 tabs.

26544 (WHC-SA–0642) **Portal metal detectors at the US Department of Energy Hanford Site.** Swank, R.G.; Riedeman, G.W. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 14p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. (CONF-9003133–1: 1990 American Society for Testing and Materials, New Orleans, LA (USA), 29-30 Mar 1990). Order Number DE90009133. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Over the past few years the US Department of Energy's Hanford Site has devoted considerable attention to improving the operation of and confidence in the commercially available metal detectors installed at the site. A set of testing and calibration specifications were prepared and applied that yielded appreciable improvements. These specifications were based on a set of tests developed to measure portal zone sensitivity and to derive the probability of detection and nuisance alarm statistics. A pragmatic approach to test article selection was also developed. This paper describes these specifications, their underlying philosophy and methodology, and the results of their application. 1 tab., 1 fig.

26545 (Y–2401) **Acoustic-emission calibration and signal conditioning instrumentation.** Duncan, M.G. Oak Ridge Y-12 Plant, TN (USA). 29 Dec 1989. 29p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OS21400. Order Number DE90007979. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An automatic calibration instrument was developed to improve calibration accuracy of acoustic-emission (AE) transducers by one order of magnitude over commercially available equipment. The instrument facilitates calibration by automatically displaying the maximum value of the stress used to produce AE calibration pulses and the AE pulse. Low-noise amplifiers and filters were also developed to improve the sensitivity of AE measurements by more than one order of magnitude over commercially available instruments; thus, smaller signals may be detected in parts. 1 ref., 20 figs., 6 tabs.

45 MILITARY TECHNOLOGY, WEAPONRY, AND NATIONAL DEFENSE

26546 (AD-A–216202/2/XAB) **Replacement study for M3A4 smoke-generator asbestos gaskets. Contractor report, August 1986-June 1987.** Dunn, K.J.; Wales, D. AAI Corp., Hunt Valley, MD (USA). Oct 1989. 46p. (AAI-R–59894-00008A). Available from NTIS, PC A03/MF A01.

This document presents a gasket replacement study performed by AAI Corporation for the U.S. Army Chemical Research, Development and Engineering Center. The new gaskets will replace those currently used in the M3A3 Smoke Generator. In accordance with Delivery Order 0002, AAI performed the following tasks: (1) Conducted a literature and industry search for new gasket material, (2) Selected and procured four of the most promising replacement materials, (3) Tested gaskets fabricated from these materials using a GFE M3A3 Smoke Generator, and (4) Recommended final

replacement gaskets based on cost, chemical and temperature resistance, and test performance.

26547 (AD-A-216308/7/XAB) **Event-train restoration via backpropagation neural networks. Interim report, January-July 1989.** Raeth, P.G. Air Force Avionics Lab., Wright-Patterson AFB, OH (USA). Dec 1989. 39p. (WRDC-TR-89-1149). Available from NTIS, PC A03/MF A01.

This project is investigating backpropagation neural networks for specific applications in passive electronic warfare involving restoration of deinterleaved event trains to their original broadcast form. This is different from traditional bit-error detection/correction which relies on a prior knowledge of what the original bit stream looked liked. In electronic warfare it is unlikely that such prior knowledge will be available. Results of this research can be applied to 3 major problem areas: (1) pulse-train restoration, (2) communications signal compression, and (3) data compression.

26548 (CONF-9004162-1) **Part-task trainers for complex cognitive skills: Evaluation of the user interface.** Hartley, D. (Tennessee Univ., Knoxville, TN (USA). Dept. of Management); Terranova, M.; Carter, R.J.; Snyder, C.E. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. From CHI '90: conference on human factors and computing systems; Seattle, WA (USA); 1-5 Apr 1990. Order Number DE90009240. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Military preparedness has become more dependent upon effective human-computer interaction. Interactive computer systems are playing major roles in training the military. Simulation of the total system, as physically realistic as budgets allow, has been the military's approach to training. Several factors now lead to consideration of part-task trainers (PTTs) for single, complicated tasks. One factor is difficulty of maintaining simultaneous delivery of the weapons system and the complete simulator. A second factor is the difficulty of keeping up with modifications of the weapons system. Another is the need for on-the-job refresher training in distant fields of operation where the simulator is not available. Because part-task trainers are in a sense, modules, they increase the maintainability and adaptability of the total training system and the acceptability of partial simulation when operational systems are very complex. 7 refs.

26549 (ORNL/TM-11273) **Arsenal of democracy in the face of change: Issues and policy options in industrial preparedness planning: Working paper No. 2.** Bjornstad, D.J.; Hardy, B.H. Oak Ridge National Lab., TN (USA). Mar 1990. 45p. Sponsored by U.S. Federal Emergency Management Agency. DOE Contract AC05-84OR21400. Order Number DE90010207. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper is one of a set of working papers that serves as a background material to a FEMA-sponsored study of Industrial Mobilization planning. It identifies issues that will lead to policy alternatives in support of industrial preparedness. To do this, a simple framework cross classifying types of economic interaction between the DOD and the private sector, given peacetime, surge, and mobilization requirements. Next, policy recommendations from ten recent studies are examined. These came from a variety of different groups and focused on potential actions by DOD, FEMA, Congress, the Navy, and others. These are summarized and restated to match the cross classification framework. The planning framework is then used to organize a set of recommendations around three themes — acquisition and public/private sector relationships technology and factor input enhancing activities, and offshore sourcing and international competitiveness. The DOD has already addressed the acquisition issue at great length and has implemented the bulk of its findings. These will undoubtedly increase the effectiveness and efficiency of its operations. It cannot, however, by itself fully rationalize the acquisition process so that incentives to achieve greater efficiency are fully passed on to contractors. DOD can, however, revise its acquisition process so that surge provisions are a deliberate step in the contract of each sensitive procurement, and could require a surge analysis for each action, steps that would highlight preparations for surge. DOD should consider the creation of a new institution similar to, but more generic than SEMATECH to handle its activities that directly enhance the defense industrial base. It should also support the creation of a body whose goal it is to identify non-neutralities in government policy. 23 refs., 1 fig., 15 tabs.

26550 (ORNL/TM-11367) **Parameter identification for generalized Lanchester's equations.** Culioli, J.C.; Protopopescu, V. Oak Ridge National Lab., TN (USA). Mar 1990. 17p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. Order Number DE90010208. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The validation of analytic combat models is hindered by the almost complete lack of a priori knowledge about the aggregated attrition coefficients serving as inputs in such models. To overcome this difficulty we discuss the applicability of two methods that use empirical data (combat outcomes) to identify the unknown attrition coefficients. Both methods are based on the minimization of an optimization criterion (equation error criterion or output error criterion). 14 refs., 12 tabs.

4501 Chemical Explosions and Explosives

Refer also to citation(s) 25555, 26318, 26537

26551 (AD-A-216218/8/XAB) **Quantification of explosion source characteristics from near-source, regional and teleseismic distances. Final report, 23 February 1987-31 July 1989.** Stump, B.; Reamer, S.; Anderson, D.; Olsen, K.; Reinke, R. Southern Methodist Univ., Dallas, TX (USA). Dept. of Geological Sciences. 31 Jul 1989. 182p. (SMU-G-6). Available from NTIS, PC A09/MF A01.

Work over the contract period is summarized in four papers: (1) Source Parameter Estimation for Large, Bermed, Surface Chemical Explosions; (2) Seismic Wave Generation by Mine Blasts; (3) Pomona Quarry Seismic Experiment, Near-Source Data; and (4) MISTY ECHO, The Seismic Source Physics Experiment. The first paper attempts to qualify source differences between large surface chemical explosions ranging in yields from 0.075 to 1.65 kilotons. The second paper documents millisecond delay blasting practices in the mining industry and illustrates the effects of these practices on near-source seismic observations. The effects of scatter in design blasting times is illustrated. A set of experiments designed to begin the comparison between single and production mining explosions are described in the third paper. The multiple explosion production shot was documented with high speed photography so that the design and actual firing times of the individual explosions could be compared. The final paper is a preliminary data report describing the first of a series of free field and free surface seismic experiments designed to document the effects of the free surface on seismic radiation from underground nuclear explosions. The particular experiment, MISTY ECHO, was detonated in Rainier Mesa at the Nevada Test Site.

26552 (LA-UR-90-898) **Discrete modeling of beds of propellant exposed to strong stimulus.** Stewart, D.S. (Illinois Univ., Urbana, IL (USA). Dept. of Theoretical and Applied Mechanics); Asay, B.W. Los Alamos National Lab., NM (USA). [1989]. 23p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-891179-1: Workshop on dynamical issues in combustion theory, Minneapolis, MN (USA), 13-17 Nov 1989). Order Number DE90008932. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper is a description of experimental and theoretical modeling concepts that are being developed to describe the behavior of confined propellant beds made of discrete particles, when subjected to a strong stimulus such as the impact of a penetrating jet. A principal goal is to discover basic mechanisms within the bed that control a reactive wave that either fails and extinguishes, or propagates as a rapid burning or detonating wave. This paper is an extended version of a lecture given by D.S. Stewart at the Institute for Mathematics and its Application in November of 1989. 4 refs., 11 figs.

26553 (SAND-89-2344C) **A unique gun application for both high velocity and low velocity projectiles in a standard 155mm long tom gun.** Garcia, J.R. Sandia National Labs., Albuquerque,

NM (USA). [1990]. 38p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004163–1: 1990 gun and ammunition technical meeting, Annapolis, MD (USA), 5-6 Apr 1990). Order Number DE90008678. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Terminal Ballistics Facility at Sandia National Laboratores in Albuquerque, New Mexico has developed an inexpensive and reliable capability for environmental testing of nuclear and kinetic energy weapon systems using the standard military 155 mm long tom gun. An unusual priming technique and charge configuration developed by Sandia National laboratories provides repeatable results such that payloads may be launched outside of the normal operating regime (both high and low) for the 155 mm gun. A 15 pound payload was reliably launched at 1000 fps with a breech pressure of 3000 psi. Another 20 pound payload was reliably launched to 5000 fps with a breech pressure of 50000 psi. A detailed description of charge configuration and test results is presented. 21 figs., 4 tabs.

4502 Nuclear Explosions and Explosives

Refer also to citation(s) 25886, 25887, 25888, 25889, 25890, 25891, 25892, 25893, 25894, 25895, 25896, 25897, 25898, 25899, 25900, 26553, 26561

26554 (PB–90-156183/XAB) **Containment of underground nuclear explosions.** Office of Technology Assessment (U.S. Congress), Washington, DC (USA). Oct 1989. 83p. (OTA-ISC–414). Available from NTIS, PC A05/MF A01.

Also available from Supt. of Docs.

The report reviews the safety of the nuclear testing program and assesses the technical procedures used to test nuclear weapons and ensure that radioactive material produced by test explosions remains contained underground.

26555 (PB–90-157322/XAB) **Joint AEC-DOD (Atomic Energy Commission-Department of Defense) nuclear weapons development procedures. Instruction.** Gilson, J. Assistant Secretary of Defense (Atomic Energy), Washington, DC (USA). 21 Jan 1974. 38p. (DOD-I–5030.55). Available from NTIS, PC A03/MF A01.

The Instruction supplements the provisions of and delineates responsibilities assigned under DoD Directive 5030.2. It provides uniform procedures for the submission of requests for, and the conduct of, Joint AEC-DoD Phase 1 through Phase 5 nuclear weapons conceptual/feasibility studies and development projects. It also includes the prescribed format and content of Military Characteristics and the Stockpile-to-Target Sequence and outlines procedures to be followed by the Design Review and Acceptance Group in conducting reviews of nuclear weapons designs.

26556 (SAND–89-2427C) **Tandem warhead considerations for electronic safety and arming devices.** Dell, D.; Medina, A. Sandia National Labs., Albuquerque, NM (USA). [1990]. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004160–1: 34. annual fuze section meeting, San Diego, CA (USA), 4-5 Apr 1990). Order Number DE90009006. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

There are four issues that an ESA designer must address when designing a tandem system: (1) warhead detonation shock, (2) warhead detonation ion cloud, (3) warhead detonation electromagnetic pulse, and (4) slapper/sparkgap electromagnetic pulse. Each of these hazards can upset the ESA time delay circuitry which would then either dud the munition or prematurely detonate the main charge. 14 figs.

26557 (SAND–90-0021) **Electromagnetic launcher studies of breakup and aerosol formation in molten uranium alloy.** Benson, D.A.; Rader, D.J. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 71p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC04-76DP00789. Order Number DE90007952. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

An understanding of dispersal of nuclear materials from an explosive event is needed to support design studies of weapon storage and transportation. Assessing the consequences and requirements for cleanup of a fire or nonnuclear detonation of a system containing nuclear material requires knowledge of the aerosol formation process. Information about the aerosol chemical composition, the physical size and shape of the particulates, as well as the efficiency of aerosol formation ate needed to conduct meaningful assessments. This report describes laboratory tests to study aerosol from materials of interest. An electromagnetic launcher is used to heat and propel molten metallic samples under energetic high-velocity conditions. We describe the apparatus and first results from tests using uranium-molybdenum alloy samples. Contained laboratory-scale measurements are described that determine aerosol morphology, chemical composition, and aerosol formation efficiency under high-velocity conditions. Data from the launcher tests describe (1) the aerodynamic breakup process of high-velocity molten liquid into droplets, and (2) the formation of still finer aerosols by combustion of these droplets at high velocity. The measurements show efficient aerosol production in air that is dominated by the formation of fine chain-agglomerate combustion aerosol. Particle morphology information for both the chain agglomerate and the less common liquid breakup products is described. The aerodynamic breakup of the liquid sample material is described. Lognormal distributions are shown to accurately represent the data. The geometric mean diameter is related to the mass mean diameter and maximum stable droplet diameter for the distributions. 28 refs., 27 figs., 3 tabs.

26558 (UCRL-ID–103137) **Barnwell ground motion and structural response measurements.** Manning, P.A.; Woehrle, T.G.; Burdick, R.B. Lawrence Livermore National Lab., CA (USA). 7 Feb 1990. 88p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90007928. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The scheduling and execution of nuclear tests at the Nevada Test Site is highly dependent on the predicted interactions between nearby tests. The primary concerns during interactions are damage to the diagnostic canister and compromise of safety at the event site. This report documents the measured ground motion and the measured structural response of some key structures at the BARNWELL event site during the CONTACT and HORNITOS events. The ground motion was analyzed in both the time and frequency domains. The time domain data was used for comparison with the ground motion predictions. Frequency domain analysis of the ground motion is useful in evaluating the current structural responses and in making future structural response predictions. The structural response of the diagnostic canister, the canister assembly tower, and the crane used to suspend the canister were measured and analyzed in both the time and frequency domains, in order to aid in future predictions. 5 refs., 33 figs.

4503 Nuclear Explosion Detection

Refer also to citation(s) 25588

26559 (UCID–21870) **Oklahoma deep-borehole seismic-noise measurements: Characteristics as a function of depth in the presence of high-surface noise.** Harben, P.E. (Lawrence Livermore National Lab., CA (USA)); Lawson, J. Lawrence Livermore National Lab., CA (USA). 25 Jan 1990. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90007921. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Ways of improving technologies for monitoring test ban treaties are being examined. One aspect of those studies is investigating ways of maximizing the seismic signal-to-noise ratio (SNR) from seismic treaty monitoring stations. To maximize SNR, the highest quality seismometers, data acquisition and data analysis capability must be obtained. The stations must also be located at sites with low seismic noise and/or boreholes to reduce seismic noise. This paper presents the data and results obtained in measuring seismic noise as a function of depth in the Oklahoma borehole with a large nearby surface-noise source. 7 refs., 10 figs.

4504 Nuclear and Radiological Warfare

26560 (AD-A–215905/1/XAB) **Swords of armageddon: A decision of the strategic mystique.** Myers, G.E. Air Univ., Maxwell

AFB, AL (USA). Airpower Research Inst. Jan 1987. 34p. (AU-ARI-CP–87-1). Available from NTIS, PC A03/MF A01.

To most Americans, our military and civilian political leaders included, the concept of strategic bombardment brings to mind a myopic vision of nuclear horror; and the long-range delivery systems most commonly associated with strategic warfare–the bombers and intercontinental ballistic missiles–are not supported either by a review of the history of modern warfare or by current statements of air power doctrine, but they persist as a legacy of the destructiveness of the World War II strategic air campaigns and the enduring Soviet-American nuclear confrontation. This paper attempts to dispell these notions and advance a concept of flexibility in strategic force application and US strategic policy formulation. It suggests that individual strategic actions have relevance in large and small, nuclear or nonnuclear wars and that our bombers and even our intercontinental missiles can and should be considered as viable force options in a variety of scenarios. The discussion concludes that strategic attack has historically been and will continue to be an active military mission that can be accomplished in numerous ways by a wide variety of weapons and delivery systems despite a continuing mystique of nuclear holocaust.

26561 (AD-A–215906/9/XAB) **Nuclear winter: Asymmetrical problems and unilateral solutions.** Reule, F.J. Air Univ., Maxwell AFB, AL (USA). Airpower Research Inst. Sep 1986. 49p. (AU-ARI-CP–86-1). Available from NTIS, PC A03/MF A01.

Nuclear winter creates a dilemma for policymakers. Awareness of that dilemma may not be new, however. Long before the phrase nuclear winter became popular, policymakers may well have been aware of the possibility that the indirect effects of a nuclear exchange could be more damaging than the direct effects. Nevertheless, the more widespread public awareness of such a possibility deepens the dilemma and makes it more apparent. The policymakers' dilemma arises from their requirement to create a perception of security from any and all threats. To do this they must be able to credibly threaten to use nuclear weapons in order to deter their use by others. These threats can be tacit, arising from the very existence of nuclear delivery systems, or direct, as evidenced by the instances of missile rattling that have occurred over the years. In either case, such threats begin to ring hollow if the policymakers are known to believe that carrying them out could result in nuclear winter. If policymakers keep secret their personal beliefs about nuclear winter they can still credibly threaten to use nuclear weapons but they have difficulty believing their own threats. Further, they cannot capitalize on the deterrent value of nuclear winter and must live in fear that their bluff may some day be called or that any of the other nuclear powers could cause a nuclear winter out of ignorance.

26562 (LA–11751) **The future of nuclear weapons: Final study report.** Garrity, P.J. Los Alamos National Lab., NM (USA). Feb 1990. 34p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90007977. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report summarizes the findings of a three-year study by the Center for National Security Studies (CNSS) that evaluated the long-term (thirty-year) future of nuclear weapons. The Future of Nuclear Weapons (FNW) Study sought (a) to identify and analyze the key long-term political, military, and technical trends that will influence the future of nuclear weapons in order (b) to provide a basis for analyzing the impact of these trends on future Department of Energy/Los Alamos programs and activities. The FNW Study was not intended to predict which specific nuclear weapons systems that the United States will deploy in the year 2020. The FNW Study was instead designed to develop insights rather than specific and detailed conclusions about the future of nuclear weapons. These insights are offered to challenge the reader and identify the appropriate issues for further consideration, and not to predict that a particular future nuclear course is preordained.

26563 (PB–90-156142/XAB) **United States Nuclear Command and Control System Support Staff. Directive.** Kennedy, R. Yourstone (Evelin), Albuquerque, NM (USA). 3 Feb 1988. 8p. (DOD-D–3150.6). Available from NTIS, PC A02/MF A01.

The Directive establishes, pursuant to National Security Decision Directive, August 21, 1987, and the authority vested in the Secretary of Defense, the U.S. Nuclear Command and Control System Support Staff under the direction, authority, and control of the Secretary of Defense, who also serves as the Executive Agent for the Nuclear Command and Control System (NCCS) (hereafter referred to as Executive Agent). The Directive establishes the DoD NCCS Executive Review Committee (ERC) in support of the Secretary of Defense. It assigns the responsibilities, functions, relationships and authorities of the U.S. NCCS Support Staff (NSS) and its Director, and those of the ERC.

26564 (WSRC-RP–89-1443) **Trip report, Interagency Manufacturing Operations Group (IMOG) Steering Committee meeting, November 29, 1989.** Butterworth, R.R. Westinghouse Savannah River Co., Aiken, SC (USA). 6 Dec 1989. 27p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (EPD-DSS–89-0074). Order Number DE90009259. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

As the Subgroup Chairman for the Process Automation & Control Technology Subgroup of IMOG, I was requested to attend the annual Steering Committee Meeting held this year at the Allied-Signal Kansas City Plant and summarize the past year's activities of the Subgroup. The next IMOG Steering Committee Meeting will be held November 14 and 15, 1990 in Los Alamos. The next Process Automation & Control Technology Subgroup Meeting will be held in June, 1990 in Rocky Flats.

4505 Strategic Defense Initiative

Refer also to citation(s) 26553

26565 (AD-A–216281/6/XAB) **Structured Analysis Tool Interface to the Strategic Defense Initiative architecture dataflow modeling technique. Master's thesis.** Austin, K.A. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Dec 1989. 113p. (AFIT/GCS/ENG–89D-1). Available from NTIS, PC A06/MF A01.

A software interface was designed and implemented that extends the use of Structured Analysis (SA) Tool (SAtool) as a graphical front-end to the Strategic Defense Initiative Architecture Dataflow Modeling Technique (SADMT). SAtool is a computer-aided software engineering tool developed at the Air Force Institute of Technology that automates the requirements analysis phase of software development using a graphics editor. The tool automates two approaches for documenting software requirements analysis: SA diagrams and data dictionaries. SADMT is an Ada based simulation framework that enables users to model real-world architectures for simulation purposes. This research was accomplished in three phases. During the first phase, entity-relationship (E-R) models of each software package were developed. From these E-R models, relationships between the two software packages were identified and used to develop a mapping from SAtool to SADMT. The next phase of the research was the development of a software interface in Ada based on the mapping developed in the first phase. A combination of a top-down and a bottom-up approach was used in developing the software.

26566 (AD-A–216321/0/XAB) **System cost probability distributions for aces (architecture comparative evaluation study) architectures. Report for March-May 1989.** Dyer, J.L. Sparta, Inc., McLean, VA (USA). 30 May 1989. 108p. Available from NTIS, PC A06/MF A01.

The report derives functional forms and presents the probability distributions for the acquisition and program costs for strategic defense system architectures developed in the second phase of the SDIO sponsored Architecture Comparative Evaluation Study (ACES). The input data are the nominal costs for each of the elements and the cost risk distributions for three elements, one each at low, medium and high risk. These are used as the basis for the cost risk distributions for all the other elements. Both log-normal and normal, independent and correlated distributions are used as the basis for deriving the total cost risk distributions for these alternatives. The results are the probability distributions for the acquisition and program costs for each of five architectures: the DAB

Baseline, two all ground based weapon architectures and two all space based architectures. The description of the architectures and the nominal cost models are presented in the ACES report, not in this report. The results show a relatively tight + or - 10 - 15% distribution about the nominal acquisition and program costs. This is due to our including only technical cost risk and correlations. The larger uncertainty is undoubtedly political: mission, threat and funding.

4506 Chemical and Biological

Refer also to citation(s) 26053

26567 (AD-A–216388/9/XAB) **Plasma and ion fluorination for chemical hardening of synthetic rubbers. Final report, 30 September 1988-30 September 1989.** Legg, K.O. Ionic Atlanta, Inc., GA (USA). Oct 1989. 76p. Available from NTIS, PC A05/MF A01.

The purpose of this Phase I SBIR program was to investigate ways of fluorinating the surfaces of rubber materials to reduce their susceptibility to wetting and permeation by chemical warfare agents. Nitrile, butyl, and neoprene rubbers were studied. Fluorination was accomplished by direct implantation of ions into the surface and by rf plasma fluorination with freon gases. The rubber materials were examined for contact angle of diethyl malonate (DEM) drops, critical surface tension, and DEM uptake, and were characterized microscopy and ESCA. Ion implantation led to embrittlement and cracking of the surfaces, causing more rapid wetting by DEM. Plasma fluorination tended to deposit a fluorocarbon film on the surface rather than to introduce fluorine into the material. Some of the fluorinated films exhibited greater DEM initial contact angles and slower absorption, although after three hours the absorption rate increased to that of the untreated rubbers. Hence, this treatment provided some temporary improvement, but it was insufficient for proper protection.

54 ENVIRONMENTAL SCIENCES

26568 (ORNL/M–1134) **Environmental Sciences Division publications: Publication numbers 3246–3440.** Oak Ridge National Lab., TN (USA). Dec 1989. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009397. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document is a bibliography publications arranged alphabetically according to senior author and sequentially by publication number for each author. This list includes publication numbers for documents accepted for publication. It is not a list of documents published during 1989.

5401 Environmental Sciences, Atmospheric

Refer also to citation(s) 25308, 25314, 25315, 25321, 25338, 25344, 25347, 25380, 25381, 25391, 25440, 25740, 25743, 25791, 25971, 25979, 26009, 26357, 26786, 26792, 26809, 26810, 26892, 26893, 26897, 26917, 26924, 27009, 27010, 27106, 27136, 27382

26569 (ANL/CNSV-TM–186, pp. 39-57) **A perspective on the greenhouse effect and CO_2 flue gas recovery for EOR.** Rotty, R.M. (Univ. of New Orleans, LA (USA)). Argonne National Lab., IL (USA). Jun 1988. (CONF-8703302–: Workshop on recovery and use of waste CO_2 in enhanced oil recovery, Denver, CO (USA), 19-20 Mar 1987). In *Recovery and use of waste CO_2 in enhanced oil recovery. Proceedings.* Order Number DE89002803. Available from NTIS, PC A06/MF A01.

As the concentrations of greenhouse gases increase in the atmosphere, the temperatures in the lower part of the atmosphere will increase. This is a requirement to maintain the balance between the energy in the short wave incoming radiation from the sun and the energy in the long wave radiation leaving the earth. It is now certain that the carbon dioxide content of the global atmosphere is increasing. It is also clear that the combustion of fuels is a major and growing source of carbon dioxide. Although there is not yet irrefutable evidence that a climate change is occurring, evidence is mounting that a signal of a true change will soon emerge from the natural climate variability. Electric power plants released over 350 million tons of carbon as carbon dioxide during 1982. Recovery of 2 trillion cubic feet per year of carbon dioxide from power plant stacks will reduce the annual global emissions of carbon dioxide by about one-half of one percent. Thus, the recovery of carbon dioxide from electric power plants may prove profitable to electric utilities and economically useful to oil companies in the extraction of oil, but its impact on the potential greenhouse gas/climate change problem is not likely to be significant.

26570 (ANL/CNSV-TM–186, pp. 107-114) **Recovering CO_2 from stationary combustors: A bonus for enhanced oil recovery and the environment.** Wolsky, A.M.; Brooks, C. Argonne National Lab., IL (USA). Jun 1988. (CONF-8703302–: Workshop on recovery and use of waste CO_2 in enhanced oil recovery, Denver, CO (USA), 19-20 Mar 1987). In *Recovery and use of waste CO_2 in enhanced oil recovery. Proceedings.* Order Number DE89002803. Available from NTIS, PC A06/MF A01.

Argonne National Laboratory is conducting research on a new approach to recovering carbon dioxide from stationary combustors. This research is aimed at providing the private sector with the information it needs to decide whether the approach can contribute to future supplies of carbon dioxide for enhanced oil recovery. The approach includes the simultaneous recovery of other gaseous combustion products, such as oxides of sulfur and oxides of nitrogen. The product stream, essentially all carbon dioxide, could be used for enhanced oil recovery. The approach also may find application where strict air pollution controls are mandated.

26571 (CMHC–89-05661) **Indoor air quality.** Collection "constructeurs". . Canada Mortgage and Housing Corp., Ottawa, ON (Canada). [1989]. 42p. (MICROLOG–89-05661). Available from PC Canada Mortgage and Housing Corporation, Annex Bldg., 682 Montreal Rd., Ottawa, ON, CAN K1A 0P7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The purpose of the present report is to raise the awareness of buiders as to the indoor air quality of dwelling places and to give them advice as to appropriate building methods and the solution of indoor air quality problems after the occupation of the building. A list of the most common air pollutants is given together with their maximum acceptable concentrations. The report discusses the problems of the gases emanating from the ground, including radon; of indoor air pollution by outdoor air; of formaldehyde from urea-formaldehyde glue; of wood fumes from fireplaces and stoves; of the emanations from inner finishing materials; of air-suspended particulates; and of the operation of combustors and blowers. Moisture control and air pollution monitoring are also discussed.

26572 (DMU-LUFT-A–135) **Operational street pollution model (OSPM): Evaluation of the model on data from St. Olavs Street in Oslo.** Hertel, O.; Berkowicz, R. Danmarks Miljoeundersoegelse, Roskilde (Denmark). Nov 1989. 34p. Order Number DE90770690. Available from NTIS (US Sales Only), PC A03/MF A01.

A computer program for estimating the dispersion of air pollution from traffic in street canyons is evaluated. The overall aim was to improve planning and control of activities for reducing air pollution from car exhaust. It was found important to test the model during periods of low wind speeds which are mainly responsible for the highest observed concentrations of nitrogen oxides. Integration of the resulting concentrations with respect to wind direction over an angle equal to the average hourly wind direction fluctuation around the mean value, variable traffic induced turbulence as a function of traffic flow and stability correction for observations with a surface temperature inversion are all conditions which have to be taken into consideration when measuring dispersion of air pollution from street traffic. (AB) 13 refs.

26573 (DOE/FTR–90009028) **[International radiation symposium meeting, Lille, France, August 16–27, 1988]: Foreign trip report.** LeBaron, B.A. Pacific Northwest Lab., Richland, WA (USA). 30 Aug 1988. 6p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90009028. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The purpose of the trip was to attend the International Radiation Symposium, sponsored by the International Association of Meteorology and Atmospheric Physics. Recent findings of atmospheric radiation research carried out under Department of Energy contract were presented to the assembly. These included the development and validation of a method for determining total column ozone using photometric measurements in the Chappuis absorption band. Also presented were the results of a long term, multispectral study of the El Chichon perturbation to the stratospheric aerosol layer. Discussions with other key scientists in the research areas of interest were held for the purpose of developing future collaboration.

26574 (DOE/NBB–0088P) **An evaluation of the relationship between the production and use of energy and atmospheric methane emissions.** Barns, D.W.; Edmonds, J.A. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 241p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE90007982. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

The purpose of this document is to examine the role energy plays in the emission of CH_4 to the atmosphere. We begin with an overview of the CH_4 cycle, briefly discussing the current understanding of sources and sinks for CH_4. We then proceed to a detailed discussion of the energy-related sources of CH_4 to the atmosphere. These include coal mining, natural gas production and distribution, combustion of traditional biomass, and landfill methane (the rightmost four categories of figure 1.1). This examination will then be used to develop estimates of the total global energy-related emissions of CH_4. 55 refs., 26 figs., 7 tabs.

26575 (DOE/PC/71253–6) **Elemental tracers of source regions of contaminants in precipitation: Final report, November 1, 1984–October 31, 1986.** Rahn, K.A.; Heaton, R. Rhode Island Univ., Narragansett, RI (USA). Center for Atmospheric Chemistry Studies. 22 Dec 1988. 33p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-84PC71253. Order Number DE90007568. Available from NTIS, PC A03/MF A01 - OSTI.

Regional elemental tracer techniques have been extended from aerosol to precipitation. By applying neutron activation and wet chemistry to three years of event samples of rain and snow (soluble and insoluble components considered together) in southern Rhode Island, it has been demonstrated that four primary tracer elements (As, Se, Sb, V) are not measurably fractionated relative to precursor aerosol and can be used with aerosol signatures to apportion themselves plus sulfate into northeastern and midwestern contributions. On an annual average, the Midwest contributes more to precipitation than to aerosol. Unlike seasonal-mean aerosol, sources for precipitation and associated aerosol vary seasonally with winter being more-northeastern than summer. 18 refs., 4 figs., 6 tabs.

26576 (ENEA-RT-TIB–89-29) **Tunable diode laser molecular spectroscopy: Present and future applications (air pollution monitoring).** Baldacchini, G.; Bellatreccia, A.; Nencini, L. ENEA, Frascati (Italy). Centro Ricerche Energia. Sep 1989. 19p. (In Italian). (RT/TIB–89-29). Order Number DE90764310. Available from NTIS (US Sales Only), PC A03/MF A01.

In the last few years, the introduction of tunable diode lasers in molecular spectroscopy has allowed measurements of spectra with high resolution and sensitivity. This last property has been applied successfully to detect small traces of gases, pollutant or non-polluting, in the atmosphere. By using the apparatus existing in the laboratory of molecular spectroscopy, a minimum amount of 500 ppbv of ammonia in air was measured. A suitably modified spectroscopic system like this one can be used for environmental and medical monitoring.

26577 (GKSS–89/E/33) **Derivation of Phillips α-parameter from turbulent diffusion as a damping mechanism.** Rosenthal, W. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik). GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). 1989. 9p. Available from Reprint from: Komen, G.J.; Oost, W.A. (eds.): Radar scattering from modulated wind waves, Kluwer Academic Publishers (1989), p. 81-88.

It has been shown that the eddy exchange term in the momentum balance of surface waves can be the origin of dissipation that is nonlinear in terms of wave momentum. This dissipation can explain the high frequency shape of the spectrum. It can, at least qualitatively, explain the variation of the Phillips α-parameter. For instance the short fetch values of α are measured in wave banks where we can assume a rather small eddy diffusion coefficient A. The decreasing α values with increasing distance from shore indicate an increasing value of A, which could be expected from the increased turbulence created for instance by increased number of breaking events. (orig.).

26578 (GKSS–89/E/39) **Deposition of atmospheric pollutants into a North German forest ecosystem.** Michaelis, W. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik); Schoenburg, M.; Stoessel, R.P. GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). 1989. 11p. Available from Reprint from: Georgii, H.W. (ed.): Mechanisms and effects of pollutant-transfer into forests, Kluwer Academic Publishers (1989), p. 3-12.

In a North German forest stand a measuring station has been set up with the aim of supplying information on the impact of atmospheric pollutants. The results suggest that the wet deposition of heavy metals does not significantly differ from that in stands with forest decline in Southern Germany. Due to the windward location the total input is predominantly determined by dry deposition. The sulphate and chloride inputs are within the variation intervals found at other sites while the total nitrogen deposition ranges towards the upper limit. The gas concentrations show a pronounced dependence on the meteorological conditions. The long-term average values were found to be higher than at other typical sites, but they are for most gases below the recommended limits. Ozone, however, requires particular attention. The long-term mean clearly exceeds the guidelines. In general, the impact of gaseous pollutants on the forest primarily occurs during short-time episodes with high peak concentrations. There are distinct relationships between the concentrations of SO_2 or O_3 on the one hand and that of CO_2 on the other. In each case the fluxes are of opposite sign. (orig.).

26579 (GKSS–89/E/47) **Atmospheric correction of thematic mapper measurements over the wadden areas of the German Bight.** Krueger, O. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik). GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.); Hamburg Univ. (Germany, F.R.). Fachbereich Geowissenschaften. 1989. 105p. (In German). Order Number DE90767395. Available from NTIS (US Sales Only), PC A06/MF A01.

Data from Thematic Mapper, a scanning radiometer on board the earth surface-observing satellite Landsat 5, are simulated with a radiative transfer model. The transfer code, the matrix-operator-method (Fischer, 1983), is applied to data from different earth surfaces. On the basis of Gordon's method (1978) for atmospheric correction over water, an algorithm has been developed to correct for the influence of aerosols, air molecules and atmospheric trace gases on Thematic Mapper data from measurements over land surfaces. The optical thickness of a cloud-free atmosphere has therefore been varied for different aerosoltypes and surface reflectances. (orig.) With 28 figs., 4 tabs.

26580 (IC–89/430) **Acoustic sounder monitoring of windshear within the atmospheric boundary layer over Ile-Ife, Nigeria.** Adedokun, J.A. (International Centre for Theoretical Physics, Trieste (Italy)); Vaughan, O.O. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 16p. Order Number DE90622940. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A tri-axial acoustic sounder with doppler wind measuring capability has been used to measure boundary layer winds from which windshear fields have been evaluated over Ile-Ife —7.29N.4.34E— Nigeria between April and June, 1988. Correlation between SODAR derived windshear profile and a radiosonde-derived temperature profile is examined. Associated Richardson numbers have been used to categorize atmospheric layers into various stability

types. A case study of wind fields and derived windshear zones associated with a rain event has been made. (author). 14 refs, 7 figs.

26581 (KFK-PEF–50-Vol.1) **5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.** Horsch, F.; Filby, W.G.; Fund, N.; Gross, S.; Hanisch, B.; Reinhardt, W.; Seidel, A. (comps.). Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. 392p. (In German). (CONF-8903205–Vol.1: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). Order Number DE90767291. Available from NTIS (US Sales Only), PC A17/MF A01.

During the 7-9th of March 1989 the Fifth Status Report of the Project 'European Research Centre for Air Pollution Control Measures' took place at the Nuclear Research Center Karlsruhe. Progress reports on the following topics were presented: Assessment and analysis of the impacts of airborne pollutants on forest trees; distinction from other potential causes of recent forest dieback (Task 1 A); air pollution effects on human health (Task 1 C); research into atmospheric dispersion, conversion and deposition of airborne pollutants (Task 2); development and optimization of industrial-technical processes to reduce or avoid emissions (Task 3); providing instruments and making recommendations to the industrial and political sectors (Task 4). The presentations are contained in two volumes and the subject matter divided as follows: Volume 1: Task 1 A; Volume 2: Tasks 1 C, 2, 3, 4. Separate abstracts were prepared of 25 papers of the present volume 1. (orig./MG).

26582 (KFK-PEF–50-Vol.2) **5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.** Horsch, F.; Filby, W.G.; Fund, N.; Gross, S.; Hanisch, B.; Reinhardt, W.; Seidel, A. (comps.). Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. 417p. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). Order Number DE90767679. Available from NTIS (US Sales Only), PC A18/MF A01.

During the 7-9th of March 1989 the Fifth Status Report of the Project 'European Research Centre for Air Pollution Control Measures' took place at the Nuclear Research Center Karlsruhe. Progress reports on the following topics were presented: Assessment and analysis of the impacts of airborne pollutants on forest trees; distinction from other potential causes of recent forest dieback (Task 1 A); air pollution effects on human health (Task 1 C); research into atmospheric dispersion, conversion and deposition of airborne pollutants (Task 2); development and optimization of industrial-technical processes to reduce or avoid emissions (Task 3); providing instruments and making recommendations to the industrial and political sectors (Task 4). The presentations are contained in two volumes and the subject matter divided as follows: Volume 1: Task 1 A; Volume 2: Tasks 1 C, 2, 3, 4. Separate abstracts were prepared of 31 papers of the present volume 2. (orig./MG).

26583 (KFK-PEF–50-Vol.2, pp. 397-411) **Anthropogenic dust in ambient air of Baden-Wuerttemberg: Physico-chemical analysis and toxicological assessment.** Marfels, H. (Fraunhofer-Institut fuer Umweltchemie und Oekotoxikologie, Schmallenberg (Germany, F.R.)); Spurny, K.R.; Iburg, J.; Wenzel, A.; Glaser, U.; Fritsche, U.; Angerer, G.; Boehm, E.; Koenig, J.; Balfanz, E. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

The report is dealing with measurements of particulate air pollutants on seven sampling sites in the Land of Baden-Wuerttemberg in West-Germany. Concentrations of organic and inorganic particulate substances have been measured monthly during one year in the period 1987/88. Toxic and mutagenic effects of the sampled particulates were established by means of in vitro tests after extraction. The urban areas of Mannheim, Stuttgart and Karlsruhe seem to have the highest particulate air pollution of the Land of Baden-Wuerttemberg. In the downtown of Mannheim were e.g. the CP concentrations 3 times, the PCB concentrations 4 times and the concentrations of PAH even 11 times higher than the concentrations of these pollutants on remote site of the Black Forest Mountains. The monthly values as well as the annual means of all measured particulate pollutants were correlated to all seven sampling sites. (orig.).

26584 (KFK-PEF–50-Vol.2, pp. 497-511) **Measurements of air pollutants indoors and outdoors using passive samplers.** Schultz, E. (Deutscher Wetterdienst, Freiburg im Breisgau (Germany, F.R.). Zentrale Medizin-Meteorologische Forschungsstelle); Staiger, H.; Jendritzky, G. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

Measurements of NO_2, SO_2 and particulate matter by passiv sampling methods in Freiburg, FRG, was continued. Additional measurements were started in the Black Forest. Devices for indoor and outdoor sampling are different, but measuring results show no statistical significant differences ($p<5\%$). Sampling efficiency for particles is influenced by particle size and will be investigated in more detail. The biogenic particle component was marked by staining and measured by quantitative image processing. An interpolation fitting method was used to calculate the spatial distribution of air pollutants. In average NO_2 and particulate combustion products have higher outdoor values. A higher indoor level is typical for biogenic particles. NO_2-indoor values differ only little between different rooms, particle values show greater differences. (orig.).

26585 (KFK-PEF–50-Vol.2, pp. 525-535) **Emission inventories for SO_2 and NO_x with a high temporal and spatial resolution for the State of Baden-Wuerttemberg - methods and results.** Mueller, T. (Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme); Boysen, B.; Friedrich, R.; Liebscher, P.; Voss, A. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

Based on the emission inventory the IKE has elaborated for the State of Baden-Wuerttemberg during the TULLA-measuring-period, a model which will be able to calculate hourly emissions for future time periods and for given boundary conditions is developed. This paper discusses some special aspects of the emissions of the transportation sector and their dependency on meteorological data and gives a short survey of the assumptions used for the reference scenario until the year 2000. Also some estimations showing the differences between summer and winter time in the amount of emissions released by the different sectors are presented. (orig.).

26586 (KFK-PEF–50-Vol.2, pp. 537-549) **Temporal and spatial allocation of VOC- and CO-emissions in Baden-Wuerttemberg.** Obermeier, A. (Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme); Friedrich, R.; Voss, A. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status*

colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center. Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

In the context of this project an emission inventory for volatile organic compounds (VOC) and carbon monoxide (CO) is going to be made for the area of Baden-Wuerttemberg. Based on actual conditions temporal variation and spatial allocation of the emissions of important source categories will be outlined, taking into account a split-up of VOC-emissions into several compounds resp. groups of compounds. Solvent use of industry, other consumers and households as well as exhaust gases from vehicles contribute for about 152 000 t/y resp. 108 000 t/y to anthropogenic VOC-emissions in Baden-Wuerttemberg. Methods for estimating solvent emissions and preliminary results for both source types mentioned will be discussed. (orig.).

26587 (KFK-PEF–50-Vol.2, pp. 551-564) **Transport of air pollutants in Baden-Wuerttemberg - newest results from the TULLA project.** Fiedler, F. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Inst. fuer Meteorologie und Klimaforschung); Adrian, G.; Baer, M.; Hugelmann, C.P.; Nester, K.; Vogel, B.; Vogel, H.; Walk, O. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

The TULLA project was performed to study the transport of air pollutants over irregular terrain up to distances of 250 km. Besides the analysis of the observed data three-dimensional model simulations are carried out to calculate the concentration and the deposition of SO_2 and other substances. Phenomena which are connected with the diurnal variation of the mixing process are discussed. Especially the reduction of anthropogenic ozone is investigated. During the TULLA episodes no significant formation of ozone could be recognized, but the oxidation of NO leads locally to a decrease of ozone. Three-dimensional model simulations demonstrate that it is possible to calculate the transport, the dispersion and the chemical transformation of the species in a mesoscale region, using the emissions of the compounds and the large scale meteorological conditions as input parameters. Further investigations are necessary to obtain a sufficient agreement of observations and model simulations for urban areas. (orig.).

26588 (KFK-PEF–50-Vol.2, pp. 565-576) **Laser microprobe mass spectrometry (LMMS) and X-ray fluorescence analysis (XRFA) of atmospheric trace components in the particulate and liquid phase.** Gieray, R. (Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Physik); Greiner, W.; Schreiber, H.; Wieser, P. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

Continuing the studies to characterize the atmospheric aerosol by LMMS of single aerosol particles and XRFA of particle samples obtained by air filtration the following objectives are considered: (i) The determination of salts of the methanesulfonic acid in particles of the marine (Atlantic) and continental (Baden-Wuerttemberg) atmosphere. (ii) Aerosol aging processes resulting from the chemical interaction of sea salt particles with H_2SO_4 and HNO_3 in airborne state. (iii) Aircraft measurements (flight path: Stuttgart, Freudenstadt, Hornisgrinde, Rhine Valley) to investigate the origine and atmospheric dispersion of the biogenic aerosol fraction of the giant particle mode. (iiii) Comparison of analytical results obtained from LMMS and XRFA of aerosol samples collected on the occasion of the TULLA campaign using cluster analysis and absolute sensitivities. Beginning a new project to investigate the transformation of air particulate matter by water condensation and evaporation a counterflow virtual impactor (CVI) is designed and calibrated to separate fog droplets from the gaseous and particulate aerosol phase. In a second step a comparison of the residues of fog droplets (condensation nuclei and material scavenged by the liquid phase) with particles of the interstitial aerosol is started. Preliminary results indicate: The particles of the interstitial aerosol and the residues resulting from the evaporated fog droplets show different chemical compositions. Sulfate and nitrate containing carbonaceous particles preferentially appear in the fraction of the interstitial aerosol. In contrast the residues dominantly consist of sulfate species. (orig.).

26589 (KFK-PEF–50-Vol.2, pp. 577-589) **Identification of products of the chemical conversion of some selected terpenes with anthropogenic airborne pollutants (O_3, SO_2) and their determination in the forest air.** Jay, K. (Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Heisse Chemie); Stieglitz, L. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

Gasphase ozonolysis of sabinene leads to sabinaketone as main product, in glass vessels sabinene undergoes rearrangements of Wagner-Meerwein type. SO_2 reduces the formation of oxidation products during the ozonolysis of β-pinene. Sulfurorganic compounds could not be detected. On field measurements the ozonolysis products of α-pinene (pinonaldehyde), β-pinene (nopinone), sabinene (sabinaketone), limonene (β-isopropenyl-δ-acetyl-n-valerianaldehyde) and camphene (camphenilone) could be detected in the forest air. The concentrations varied from 4 ng/m^3 (camphenilone) to 580 ng/m^3 (sabinaketone) and showed a rather constant maximum in midsummer. (orig.).

26590 (KFK-PEF–50-Vol.2, pp. 591-601) **Smog chamber studies on the air chemistry of biogenic hydrocarbons in the presence of ozone, NO_x, and SO_2.** Nolting, F. (Fraunhofer-Institut fuer Toxikologie und Aerosolforschung (ITA), Hannover (Germany, F.R.)); Zetzsch, C. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

The photochemical transformation of the biogenic α-pinene was studied in a smog chamber in the presence of NO_x and SO_2. It was demonstrated that the presence of SO_2 has no measureable effect on the formation of ozone at levels of SO_2 relevant for the troposphere. The observed degradation of the SO_2 is too fast to be explained by the gas phase reaction of OH radicals alone. A major portion of the transformation is performed by transient degradation products of the terpene and by heterogeneous processes. Intensive measurement campaigns were performed at the smog chamber facility at Hannover. Using the analyzer developed at the TU Berlin (Israel and Boehm) the formation of sulphuric acid and of particulate sulphur was observed as products of the conversion of SO_2. In the absence of humidity the main product is sulphuric acid, whereas in the presence of 60% relative humidity (r.h.) the almost exclusive product is particulate sulphur. At 60% r.h. about 50% of the transformed SO_2 could be recovered in sulphurous products (about 30% in totally dry experiments). In view of the inherent additional losses by aerosol deposition this sulphur balance is quite satisfactory. (orig.).

26591 (KFK-PEF–50-Vol.2, pp. 615-625) **Measurements of sulfuric acid and sulfate particles in a clean air region and a smog chamber.** Israel, G.W. (Technische Univ. Berlin (Germany, F.R.). Fachgebiet Luftreinhaltung); Boehm, R. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches

Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

With a recently developed analyzer concentrations of sulfuric acid and sulfate particles were measured in a clean air region and a smog chamber. The photochemical experiments, which were carried out in teflon bags, showed good reproducibility. The relative humidity influenced greatly the composition of sulfur aerosols. More than 90% of these aerosols were identified as SO_4^{2-} using ion chromatographic analysis. Up to 50% of the converted SO_2 were detected as aerosols. In the clean air region sulfuric acid could be measured only in winter. In summer the concentration of sulfate aerosols were occasionally ten times higher than the concentration of SO_2. (orig.).

26592 (KFK-PEF--50-Vol.2, pp. 627-635) **Measurement of the dry deposition rates on trees by using the natural radioactivity as a tracer.** Schreiber, H. (Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Physik). Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

A significant part of the total deposition flux into canopies is the so-called dry deposition of gases and of particulate matter. In addition meteorological conditions can frequently cause a liquid phase with high concentration of pollutants on the surface of leaves and needles. The usually applied experimental methods and the model based indirect results as well need further improvement. Therefore we present tracer experiments suitable to determine the dry deposition rate in a canopy: The amount of the natural radioactivity attached to airborne particles and the resulting contamination of leaves or needles have to be measured. With these informations it is possible to calculate the deposition velocities for short periods of 1-20 hours governed by rather uniform meteorological parameters. This should be the basis to test different surrogates in the field. First experimental results are reported. (orig.).

26593 (KFK-PEF--50-Vol.2, pp. 637-650) **Pulsed electrostatic precipitators for flue gas cleaning.** Hinderer, A. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Inst. fuer Elektroenergiesysteme und Hochspannungstechnik); Schwab, A.J. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

A model electrostatic precipitator with pulsed energization was used to investigate the visual appearance of corona discharges and the corresponding I/V characteristics. Measurements at different climatic conditions show an increased collecting efficiency with pulsed energization. Two concepts for pulsed energization are presented. Moreover, a field code was augmented by a program calculating the electric capacitance of electrostatic precipitators, a significant design factor. The obtained results agree very well with values obtained from a simultaneously developed analytical approximation formula. Eventually, a test set-up for the investigation of the charging characteristics of spherical particles in a pulsed corona discharge is presented. Charges measured with charging times of 10ms in a pulsed field were 47% higher than in a constant dc field. (orig.).

26594 (KFK-PEF--50-Vol.2, pp. 651-660) **Development of a SCR-catalyst adapted to an instationary operation of the reactor.** Kotter, M. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Inst. fuer Chemische Verfahrenstechnik); Lintz, H.G.; Turek, T. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

A new NO_x abatement strategy uses the Ljungstrom heat exchanger of the power plant as a reactor. Catalysts adapted to the particular conditions of the process - instationary operation and temperature profile - have to be developed. A new preparation method allows the production of active and selective vanadia-titania catalysts for the reduction of nitric oxide by ammonia. Heat treatment of these catalysts at temperatures higher than 350deg C has been found to cause changes in the structure of the catalyst and the catalytic activity. Knowledge of the processes causing the structure changes seems to make possible the preparation of a catalyst useful for high temperature operation. (orig.).

26595 (KFK-PEF--50-Vol.2, pp. 661-676) **Simultaneous dry scrubbing of SO_2 and NO_x reduction using activated calcium based materials.** Weisweiler, W. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Inst. fuer Chemische Technik); Schmitt, R.; Lueck, M. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

Studies on NO_x reduction and NO_x sorption as well as SO_2 sorption were carried out in a fluidized bed laboratory reactor. In this report two alternatives for dry purification of flue gases were discussed. The first method based on the SCR technology for NO_x reduction in direct combination with activated calcium containing materials for SO_2 sorption. The removal of SO_2 starts at temperatures around 350deg C if special sorbents are used. Because of this temperature range only the catalyst particles activated with iron and manganese sulfate were applied for the NO_x reduction. Further studies will be performed on the SO_2/SO_3 conversion to improve the removal of these sulfur oxides by CaO or $Ca(OH)_2$ and decrease the sulfite formation in the product. The SO_2 oxidation will be achieved by a modified SCR catalyst. In a second method NO_x and SO_2 emissions were reduced by the simultaneous sorption on Calcium containing compounds below 400deg C. The reaction products were $Ca(NO_3)_2$, $CaSO_3$ and $CaSO_4$. The NO_x and SO_2 sorption is controlled by the diffusion of the gaseous compounds NO_x and SO_2 through the product layers affected by the higher molar volume of the reaction products compared to the sorbent. For first experiments flue gas containing NO_x but no SO_2 and sorbents calcined in a fluidized bed are applied. (orig./EF).

26596 (KFK-PEF--50-Vol.2, pp. 677-704) **Combined separation and retainment of particulate and gaseous matter by fibrous filters scrubbing of SO_2 from flue-gases through reaction with calcium-compounds in filter-cakes.** Loeffler, F. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Inst. fuer Mechanische Verfahrenstechnik und Mechanik); Gaeng, P. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

The binding of gasses to fine-grain sorbents prior to and during their filtration with fibrous (e.g. bag) filters presents an economical possibility of reducing gasseous and particulate pollutants, generated by small and average-sized process plants, down to the limits stipulated by the environmental-control regulations. During the course of filtration with fibrous materials, a superficial cake is formed, itself serving as the true filter medium. Under favourable conditions, this extremeley pourous layer ($\epsilon \simeq 0,8$) can also be simultaneously employed as a reactor for the extraction of gasseous pollutants, such as SO_2, SO_3, HCl and HF. The sorbents suited to this task include $CaCO_3$, $Ca(OH)_2$, CaO or Dolomite, depending on which gas one desires to purge. This project is concerned with the theoretical and experimental investigation of the collection of particulate substances at elevated temperatures and the reaction of gasses within the cakes generated. Experiments on gas-solid reaktion have been carried out with SO_2 and filter cakes of $CaCO_3$ and $Ca(OH)_2$ which under appropriate conditions form CaO and will react with the gas. Break-through curves measured at temperatures up to 650deg C show that a gas cleaning efficiency of almost 100% is achievable even with filter cakes thinner than 1 mm. (orig.).

26597 (KFK-PEF–50-Vol.2, pp. 705-722) **Optimization of the separation of particles at high temperatures and simultaneous sorption of gases in a granular bed filter - capture of SO_2 and determination of the pollutant gas situation in a secondary aluminium plant in Stockach.** Peukert, W. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Inst. fuer Mechanische Verfahrenstechnik und Mechanik); Loeffler, F. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

In recent years, the application of granular bed filters for hot gas cleaning has been increasingly discussed. One advantage of this filter type is its relatively simple, but robust design, allowing application at temperatures of up to 800deg C and beyond. The utilization of reactive filter media additionally facilitates the chemical sorption of gases such as SO_2 or HCl by the filter medium. Experimentally determined breakthrough-curves of SO_2 through packed bed reactors consisting of limestone pellets are presented. The influence of important filtration parameters are discussed. Favourable breakthrough characteristics coupled with high solid conversions are especially achieved when using pellets of limestone dust particles, orginally in the micron size range. In addition to laboratory experiments, the flue-gas situation of the secondary aluminium plant in Stockach is considered. Based on the quantitive flue-gas analysis, solutions are derived for the waste gas cleaning using granular bed filter technology, whilst also considering the problem of the residues. (orig.).

26598 (KFK-PEF–50-Vol.2, pp. 723-739) **Aerosol formation and heterogeneous reactions in the simultaneous flue gas cleaning by electron beam treatment.** Paur, H.R. (Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Lab. fuer Aerosolphysik und Filtertechnik 1); Jordan, S.; Baumann, W.; Maetzing, H. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

By the electron beam treatment of flue gases SO_2 and NO_x are transformed into an aerosol consisting of ammonium salts. This aerosol can be removed from the flue gas by precipitators (e.g. bagfilter) and may be used as fertilizer. The removal of this aerosol was investigated with bagfilters operating in the on-line or off-line cleaning mode. The removal efficiencies for the aerosol were in general higher than 99,5%. In the on-line cleaning mode a stable filter operation is only possible by a recirculation of an inert additive. With offline cleaning the dedusting efficiencies of the filterbags were about 95% during a 30 hour experiment. By a stepwise irradiation of the flue gas an improvement of the G-values for the NO_x-removal has been observed. This method works especially well, if the products (NO_2) are removed in between the irradiation steps. The numerical simulation of the e-beam process has been improved by adding a module which treats the aerosol formation. With this improved code heterogeneous reactions have been investigated. While this reaction type seems to have little importance in the SO_2-oxidation it is crucial for the modelling of the NO_x-chemistry because of the decomposition of HNO_2. (orig.).

26599 (KFK-PEF–50-Vol.2, pp. 741-753) **Simultaneous flue gas cleaning (desulfurization, denitrification) by means of electron beam irradiation.** Wittig, S. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Inst. fuer Thermische Stroemungsmaschinen); Platzer, K.H.; Willibald, U. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

The understanding of the processes governing the simultaneous removal of NO_x and SO_2 is based on the analysis of the radiation-induced chemical reaction mechanisms. In addition, numerous experiments have been conducted to study the process characteristics. The results have been correlated in a phenomenological model describing the removal of the pollutants, leading to realistic predictions of the energy requirements and the removal efficiencies. The operation of a pilot plant provides a large set of practical experiences for an assessment of the e-beam process under large-scale technical conditions. (orig.).

26600 (KFK-PEF–50-Vol.2, pp. 755-764) **Denitrification and desulfurization of flue gas by corona discharge.** Scheuermann, A. (Stuttgart Univ. (Germany, F.R.). Inst. fuer Physikalische Elektronik); Bloss, W.H. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

Corona discharges and silent discharges (dielectric barrier discharges) can initiate chemical reactions in flue gases by the formation of reactive species, converting the noxious gases NO_x ($NO+NO_2$) and SO_2 mainly to corresponding acids. The effect of these gas discharges was examined by laboratory experiments using synthetic gas mixtures. Experiments with steady corona discharges in wire-cylinder-arrangements showed that the concentrations of NO, NO_x and SO_2 can be reduced. Degrees of conversion strongly depend on gas composition, especially on the components H_2O and NH_3. In general the energy efficiency of corona discharges is relatively small. The energy efficiency concerning the conversion of NO and NO_x increases by at least a factor of two when experiments with the silent discharge are compared to experiments with corona discharges, whereas the question concerning SO_2 is not yet solved. (orig.).

26601 (KFK-PEF–50-Vol.2, pp. 795-803) **Cost-effectiveness analysis of strategies to reduce the SO2- and NOx-emissions in Baden-Wuerttemberg considering regional aspects.** Boysen, B. (Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme); Friedrich, R.; Mattis, M.; Voss, A. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF*

project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center. Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

Costs and effectiveness of several measures for reducing SO_2- and NO_x-emissions are evaluated. Regional aspects can be taken into account due to the calculations on county-level. At first the emissions are calculated for each of Baden-Wuerttemberg's 44 counties in the year 1985. The next step is the estimation of the emissions for the year 2000 on the base of the fuel use expected. This projection considers all measures which are necessary to meet the existing and future laws. In addition to this the costs and the effects of further abatement measures are given. From the results it is possible to get information about the costs necessary to reach a certain level of emissions. Furthermore it is known which measures have to be taken. This gives the opportunity to develop strategies and recommendations for a cost-effective air-pollution-control policy. (orig.).

26602 (KFK-PEF–50-Vol.2, pp. 805-815) **Analysis of eco-political instruments of air pollution control.** Friedrich, R. (Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme); Boysen, B.; Fahl, U.; Mattis, M.; Voss, A. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

To realise a rational policy for air pollution control, it is necessary to identify optimal strategies for emission reduction, that maximize social welfare. In this paper an approach and an optimization algorithm are presented, that are able to evaluate an optimal strategy even when a very large number of polluters has to be considered. In a next step the question arises, which of the eco-political instruments is best qualified to ensure, that the optimal reduction strategy identified before is carried through. To analyse that, the characteristics of the three main instruments, namely standards, charges and permits are analysed and evaluated. (orig.).

26603 (NILU/OR–26/89) **European survey for NO_x emissions, 1985.** Pacyna, J.M.; Larssen, S.; Semb, A. Norsk Inst. for Luftforskning, Lillestroem (Norway). May 1989. 51p. (UBA-FB–81-121-Vol.4). Available from Umweltbundesamt, Bismarckplatz 1, D-1000 Berlin 33. Available from Umweltbundesamt, Bismarckplatz 1, D-1000 Berlin 33.

Emission estimates are presented for NO_x from stationary and mobile sources in Europe with particular emphasis in Eastern Europe. Total emissions of NO_x in Europe were estimated to 23.9 million tons as NO_2 in 1985 with ca 50% contribution from Eastern Europe. 31 refs., 7 tabs.

26604 (NILU/OR–43/89) **Emissions of nitrogen oxides from stationary combustion sources in Western Europe in 1980 and 1985.** Semb, A. Norsk Inst. for Luftforskning, Lillestroem (Norway). Aug 1989. 40p. (UBA-FB–81-121-Vol.3). Available from Umweltbundesamt, Bismarckplatz 1, D-1000 Berlin 33. Available from Umweltbundesamt, Bismarckplatz 1, D-1000 Berlin 33.

Emission of NO_x have been estimated for 18 countries in Western Europe on the basis of fuel consumption in stationary sources and emission factors. The calculations have been performed for 1980 and 1985 and the results compared with the OECD MAP emission survey. 8 refs., 5 tabs.

26605 (NUREG/CR–5475) **Model feasibility study of radioactive pathways from atmosphere to surface water.** Smith, R.E. (Agricultural Research Service, Fort Collins, CO (USA)); Summer, R.M.; Ferreira, V.A. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation; Agricultural Research Service, Fort Collins, CO (USA). Mar 1990. 35p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

A feasibility study of the atmosphere to surface-water radionuclide pathways was performed for small catchments, using a physically-based hydro-ecosystem model, Opus. Detailed time-intensity precipitation records from Arizona and Georgia were used as input to drive the model. Tests of model sensitivity to distribution coefficients, Kd, for Cs-137, Cs-134, and Sr-90 illustrated different vegetation-soil-erosion-runoff pathways, in response to agricultural management practices. Results reflected the fact that low Kd values allow a radionuclide to infiltrate into the soil profile and isolate it from subsequent runoff and erosion. Of the radionuclides and physical settings studied, only the Sr-90, with low Kd values, is sufficiently mobile and long-lived to be removed from the system via percolation below the root zone. Conversely, highly-adsorbed radionuclides were subject to removal by adsorption to sediment particles and subsequent runoff. Comparison of different effective half-lives of I-131 demonstrated the importance of the timing of an erosion-runoff storm event during or immediately after a fallout event. Seasonal timing of a fallout event and crop management also affect the fate of this short-lived radionuclide. Removal by solution to surface-water runoff was negligible for all nuclides studied. 34 refs., 14 figs., 2 tabs.

26606 (PB–90-129685/XAB) **Tools for mapping environmental monitoring data.** Riggan, W.B.; Heiderscheit, L.T.; Creason, J.P.; Pellam, A.C. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. 1990. 9p. (EPA–600/D-89/210). Available from NTIS, PC A02/MF A01.

The data presentation tool with a variety of types of data which may contain spatial and temporal patterns of interest. The technology links mainframe computing power to the new generation of desktop publishing hardware and software to produce publication-quality maps and tables. Maps of air pollution data have now been generated which show spatial and temporal patterns for emissions as well as ambient air quality levels, using a Macintosh II computer with a laser printer.

26607 (PB–90-130469/XAB) **Survey of indoor-air-quality diagnostic and mitigation firms. Final report.** ICF-Lewin Energy, Fairfax, VA (USA). Nov 1989. 332p. Available from NTIS, PC A15/MF A02.

The document reports on a survey conducted by the U.S. Environmental Protection Agency (EPA) to help assess the capacity of the private sector to provide services related to the diagnoses and mitigation of indoor air quality problems in residential buildings, public buildings, commercial buildings, and other non-industrial environments. Questionnaires were mailed to approximately 7000 firms who EPA thought were potentially offering such services. The body of the report provides a brief summary of the survey findings. In the appendices, the report provides a copy of the questionnaire, lists the firms alphabetically and by State and city, provides addresses and telephone numbers, summarizes their answers to the questionnaire, and provides brief guidance for those seeking the services of such firms. EPA did not attempt to verify the accuracy of the responses received.

26608 (PB–90-131988/XAB) **Sources and chemistry of late winter arctic tropospheric aerosols. Doctoral thesis.** Li, S.M. National Center for Atmospheric Research, Boulder, CO (USA). 1989. 222p. (NCAR/CT–122). Available from NTIS, PC A10/MF A02.

Aerosols at Barrow from 16 March to 7 May 1986 were studied for natural components and pollutants by IC and PIXE and a receptor model. Organic acid concentrations were high, likely due to condensation. 20% of nonsea salt sulfate apparently came from marine organosulfur, traced by methanesulfonate, and 80% from NH4HSO4. Combustion aerosols resembled condensates and originated in Europe during a haze event. Sea salt originated in the Beaufort Sea or the North Pacific. Eolian dust was even present. Another aerosol component contained bromine. Ozone varied inversely with bromine when nitrate was low, arguing for a chemical link, otherwise had a pollution origin and was affected by dynamics.

26609 (PB–90-132929/XAB) **Radon in schools. Report for May 1988-September 1989.** Leovic, K.W. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. c 1989. 24p. (EPA–600/D-89/206). Available from NTIS, PC A03/MF A01.

The paper discusses radon entry into schools, radon mitigation approaches for schools, and school characteristics (e.g., HVAC system design and operation) that influence radon entry and mitigation system design. It also discusses mitigation systems installed by the U.S. EPA in four schools. The primary source of radon entry into a school with significantly elevated radon levels is normally soil gas that is drawn in by pressure differentials between the soil surrounding the substructure and the building interior. If the building interior is at a lower pressure than the soil surrounding the substructure and radon is present in the soil, the radon can be pulled in through cracks and other openings that are in contact with the soil. The amount of radon in a given classroom depends on the level of radon in the underlying material, the ease with which the radon moves as a component of the soil gas through the soil, the magnitude and direction of the pressure differentials, the number and size of the radon entry routes, and dilution and mixing of the room air. HVAC systems in schools vary considerably and tend to have greater impact on pressure differentials–and consequently radon levels–than do heating and air-conditioning (HAC) systems in houses.

26610 (PB–90-141227/XAB) **Surface Impoundment Modeling System (SIMS), user's manual.** Watkins, S. Radian Corp., Research Triangle Park, NC (USA). Sep 1989. 40p. Available from NTIS, PC A03/MF A01.

For system on diskette, see PB–90-501115. See also PB–90-141235.

Surface impoundments are used to treat, store, and dispose of waste water generated by facilities in many different industries. The Surface Impoundment Modeling System (SIMS) is a personal computer based program designed to estimate the air emissions from surface impoundments. The emission estimates are based on mass transfer models developed by the Emissions Standards Division (ESD) of the Environmental Protection Agency (EPA) during the evaluation of hazardous waste treatment, storage, and disposal facilities (TSDF's). SIMS allows the user to specify all required inputs to these emission models when this information is available, or when only limited information is available, provides default values for most of the model inputs. The manual presents a complete reference for all of the features and commands in SIMS.

26611 (PB–90-141235/XAB) **Background document for the Surface Impoundment Modeling System (SIMS).** Watkins, S. Radian Corp., Research Triangle Park, NC (USA). Sep 1989. 184p. Available from NTIS, PC A09/MF A01.

For system on diskette, see PB–90-501115. See also PB–90-141227.

Surface impoundments are used to treat, store, and dispose of waste water generated by facilities in many different industries. The Surface Impoundment Modeling System (SIMS) is a personal computer based program designed to estimate the air emissions from surface impoundments. The emission estimates are based on mass transfer models developed by the Emissions Standards Division (ESD) of the Environmental Protection Agency (EPA) during the evaluation of hazardous waste treatment, storage, and disposal facilities (TSDF's). SIMS allows the user to specify all required inputs to these emission models when the information is available, or when only limited information is available, provides default values for most of the model inputs. The manual presents a complete reference for all of the features and commands in SIMS.

26612 (PB–90-142753/XAB) **Review and evaluation of area-source dispersion algorithms for emission sources at Superfund sites. Final report.** Touma, J.S. Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. Nov 1989. 124p. (EPA–450/4-89/020). Available from NTIS, PC A06/MF A01.

The report examines air quality dispersion modeling algorithms and related technical issues associated with estimating ambient concentrations from area sources at Superfund sites. The report describes the area source emission characteristics associated with Superfund sites and provides a review of existing, available techniques for modeling area sources. It also describes the results of applying five short-term and three long-term area source models to a number of example applications and one field data base in order to compare the magnitude of concentration predictions and test whether concentration estimates are consistent with mathematical and physical principles. The report provides conclusions and recommendations.

26613 (PB–90-142910/XAB) **Polychlorinated biphenyls: Environmental occurrence and analysis.** Safe, S.; Safe, L.; Mullin, M. Texas A and M Univ., College Station, TX (USA). Dept. of Veterinary Physiology and Pharmacology. c 1987. 16p. Available from NTIS, PC A03/MF A01.

Pub. in Environmental Toxin Series, Vol. 1, 1-13(1987).

Polychlorinated biphenyls (PCBs) are complex mixtures which have been identified in every component of the global ecosystem. The chapter discusses the distribution of PCBs in the environment and points out recent analytical advances which now permit high resolution congener-specific analysis of PCBs in diverse analytes using high resolution capillary gas chromatographic techniques. The biologic and toxic effects of PCBs are structure-dependent and the adverse environmental and human health impacts of the different mixtures of PCBs are related to the individual components of these mixtures and their interactions. The chapter points out that high resolution PCB analysis will now permit the unequivocal identification and quantitation of the individual PCBs in environmental samples and the data can be used for more accurate risk assessment.

26614 (PB–90-143017/XAB) **Relationship between mesoscale acid precipitation and meteorological factors.** Ragland, K.W.; Wilkening, K.E. Wisconsin Univ., Madison, WI (USA). Dept. of Mechanical Engineering. c 1982. 22p. Available from NTIS, PC A03/MF A01.

Pub. in Acid Precipitation: Effects of Ecological Systems, Chapter 6, 123-139.

The chapter deals with sulfur dioxide and sulfate deposition from the atmosphere to the ground. Sulfur dioxide may be transformed to sulfate compounds in the atmosphere and in vegetation, soil, and water. The extent to which sulfur deposition changes the pH of the soil and water is not addressed here. Rather, sulfur loading is taken as an indicator of potential for acidification. Nitrogen compounds may also produce acidification; however, less is known about these processes and they are not considered here.

26615 (PB–90-143165/XAB) **Determination of rates of reaction in the gas-phase in the troposphere. Theory and practice. 1. Hierarchal test scheme.** Leifer, A. Environmental Protection Agency, Washington, DC (USA). Office of Toxic Substances. Nov 1989. 28p. (EPA–560/5-89/006). Available from NTIS, PC A03/MF A01.

The document represents a detailed report on a two-tiered hierarchical test scheme for determining the rate constants k(dE), k(OH), and k(O3) (the second-order rate constants for direct photoreaction and indirect photoreaction with hydroxyl radicals and ozone, respectively) and estimating the half-lives (t(sub(1/2)E)) for each of these transformation processes and the net half-life in the gas-phase in the troposphere. The test scheme is organized so that estimation techniques are used as screening tests at the first level of testing followed by the laboratory methods as upper-tier tests. These screening tests give a rough estimate of the fate of a chemical in the gas-phase in the troposphere. Depending upon the results of these screening tests and the requirements in a risk-assessment, upper-tier laboratory tests should be used to obtain more detailed and reliable information to determine the fate of a chemical in the gas-phase in the troposphere.

26616 (PB–90-143447/XAB) **Aerosol industry success in reducing CFC (chlorofluorocarbon) propellant usage. Final report, January-September 1989.** Nelson, T.P.; Wevill, S.L. Radian Corp., Austin, TX (USA). Nov 1989. 227p. Available from NTIS, PC A11/MF A02.

The two-part report discusses the reduction of chlorofluorocarbon (CFC) propellant usage. Part I discusses the U.S. aerosol industry's experience in converting from CFC propellants to alternative aerosol formulations. Detailed examples of non-CFC formulations are provided for 28 categories of aerosol products. Hydrocarbon propellants, which cost less than CFCs, are most often selected as the propellants of choice unless special properties (e.g., increased solvency or reduced flammability) are needed. Dimethyl ether is

the next most preferred CFC alternative although it is flammable and a strong solvent. Carbon dioxide, nitrous oxide, and nitrogen are inexpensive and widely available, but have been underused as aerosol propellants. Special equipment is often needed to add them to the aerosol containers.

26617 (PB–90-145772/XAB) **Indoor air: Reference bibliography.** Campbell, D.; Staves, D.; McDonald, S. Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. Jul 1989. 341p. (EPA–600/8-89/067F). Available from NTIS, PC A15/MF A02.

The U. S. Environmental Protection Agency initially established the indoor air Reference Bibliography in 1987 as an appendix to the Indoor Air Quality Implementation Plan. The document was submitted to Congress as required under Title IV–Radon Gas and Indoor Air Quality Research of the Superfund Amendments and Reauthorization Act of 1986. The Reference Bibliography is an extensive bibliography of reference materials on indoor air pollution. The Bibliography contains over 4500 citations and continues to increase as new articles appear.

26618 (PB–90-145830/XAB) **Southern California Air Quality Study: Quality-assurance program. Final report.** Collins, J.; Fujita, E. ENSR Consulting and Engineering, Camarillo, CA (USA). 30 Nov 1989. 212p. (ENSR-DOCUMENT–1200-004-001). Available from NTIS, PC A10.

Portions of this document are not fully legible.

The methods and results of the Quality Assurance Program for the Southern California Air Quality Study (SCAQS) are described. The QA program included reviews of each participants standard operational and quality control procedures and on-site system audits prior to and during the field study. Performance audits included: continuous CO, SO_2, O_3, NOx, and THC analyzers, meteorological instruments; flow rates for the SCAQS aerosol samplers, nephelometers, and carbonyl samplers; and analysis of ion chemistry. In addition, laboratory comparison studies were coordinated for elemental analysis, speciated hydrocarbons, light absorption and peroxyacetyl nitrate.

26619 (PB–90-146291/XAB) **Determination of rates of reaction in the gas phase in the troposphere: Theory and practice. 2. Rate of direct photoreaction.** Leifer, A. Environmental Protection Agency, Washington, DC (USA). Office of Toxic Substances. Nov 1989. 55p. (EPA–560/5-89/007). Available from NTIS, PC A04/MF A01.

The report describes in detail a simple and cost-effective screening test for estimating an environmentally relevant maximum rate constant and minimum half-life for direct photoreaction of a chemical in the gas-phase in the troposphere. The report discusses the theory and development of the screening test and describes detailed procedures for measuring the cross section of a chemical in the gas-phase in the laboratory by spectroscopic techniques and data reporting for sections 4 and 5 of TSCA (Toxic Substance and Control Act.) Tables of solar irradiance (J_λ) are given from 0° to 70° North latitude in 10 degree increments as a function of season of the year to cover the continental United States and other parts of the U.S., such as Alaska and Hawaii. An example is given to illustrate the use of the experimental cross section data and solar irradiance data (J_λ) to estimate the maximum rate of direct photoreaction (kdE)max and the minimum half-life $t_{\frac{1}{2E}}$ /min.

26620 (PB–90-146416/XAB) **Air Emissions Species Manual (addendum). Final report, April 1988-October 1989.** Brooks, G.W.; Waddell, J.T.; Butler, A. Radian Corp., Research Triangle Park, NC (USA). Oct 1989. 311p. Available from NTIS, PC A14/MF A02.

See also Volume 1, PB–88-225792 and Volume 2, PB–88-225800.

The U.S. Environmental Protection Agency (EPA) has several activities that require speciated particulate matter (PM) or volatile organic compound (VOC) profiles from several source categories. In an effort to update the available speciated PM profile data base, EPA has initiated studies to update various reference manuals. This document updates the PM profiles in the Air Emissions Species Manual, Volume II with new information obtained from contacts with principal researchers in the field of PM species profiles and source receptor modeling. The new profiles were developed using the procedures and protocols specified in the original Air Emissions Species Manual, Volume II. The profiles are based on data submitted by the researchers.

26621 (PB–90-146697/XAB) **Nonmethane organic compound monitoring program. Final report 1988. Volume 2. Urban air toxics monitoring program.** McAllister, R.A.; Moore, W.H.; Rice, J.; Dayton, D.P.; Jongleux, R.F. Radian Corp., Research Triangle Park, NC (USA). Apr 1989. 277p. Available from NTIS, PC A13/MF A02.

See also report for 1987, PB–89-107890.

From October, 1987 to October, 1988 samples of ambient air were collected at 19 sites in the eastern part of the U.S. Every 12 days, air was integrated over 24-hour periods into passivated stainless steel canisters. Simultaneously, air was drawn through cartridges containing dinitrophenylhydrazine to collect carbonyl compounds. The samples were analyzed at a central laboratory for a total of 37 halogenated and aromatic hydrocarbons, formaldehyde, acetaldehyde, and other oxygenated species. The hydrocarbon species were analyzed by gas chromatography/multiple detectors and gas chromatography/mass spectrometry, while the carbonyl species were analyzed by liquid chromatography. An extensive quality assurance program was carried on to secure high quality data. Complete data for all the hydrocarbon samples are presented in the report.

26622 (PB–90-148875/XAB) **Seedling response to sulfur, nitrogen, and associated pollutants.** Peterson, C.E.; Mattson, K.G.; Mickler, R.A. NSI Technology Services Corp., Corvallis, OR (USA). Nov 1989. 110p. Available from NTIS, PC A06/MF A01.

In 1986, the National Acid Precipitation Assessment Program (NAPAP) established the Forest Response Program (FRP) to assess the effects of acidic deposition and associated pollutants on forests. Seedling exposure studies were initiated to determine acute effects of simulated acid deposition, ozone, and sulfur dioxide, and to identify hypothesized mechanisms be which these effects might alter tree condition and hence result in forest decline. From data available as of December 1988, altered post-exposure growth and imbalance in above- and below-ground responses to sulfur dioxide indicated changes in carbon allocation patterns. Simulated acid precipitation reduced frost hardiness of red spruce seedlings at pH 3.0 and led to higher rates of foliar tissue mortality during extreme cold. Loblolly pine showed root and stem growth decreases at ozone levels 80 ppb and higher. Of western conifers, only ponderosa pine showed consistent growth decreases due to ozone.

26623 (PB–90-149816/XAB) **Intercomparison of precipitation chemistry data obtained using CAPMoN and NADP/NTN protocols. Technical memo.** Vet, R.J.; Sirois, A.; Lamb, D.; Artz, R. National Oceanic and Atmospheric Administration, Silver Spring, MD (USA). Air Resources Lab. Aug 1989. 66p. (NOAA-TM-ERL-ARL–174). Available from NTIS, PC A04/MF A01.

The study compares data obtained using the equipment and protocols of the U.S.-based National Atmospheric Deposition Program/National Trends Network (NADP/NTN) with data from the Canadian Air and Precipitation Monitoring Network (CAPMoN). This intercomparison focuses on the differences in sampling interval employed in each network (weekly in NADP/NTN; daily in CAPMoN), as well as on the comparability of the overall network operations. Given sufficient comparability and the relatively high spatial density of sites in each network, it may be possible to combine these two data sets and so be able to develop isopleth maps that span the U.S.-Canadian border without major discontinuities. After a description of the sampling sites and protocols used in the study, the authors consider the analytical methods used to process and intercompare the data. Actual results are presented and discussed.

26624 (PB–90-149972/XAB) **Alternative formulations to reduce CFC (chlorofluorocarbons) use in US exempted and excluded aerosol products. Final report, April-September 1989.** Nelson, T.P.; Wevill, S.L. Radian Corp., Austin, TX (USA). Nov 1989. 155p. Available from NTIS, PC A08/MF A01.

The report examines products exempted and excluded from those affected by the 1978 ban on the use of chlorofluorocarbons

(CFCs) as aerosol propellants, the present consumption of CFCs still utilized for these products in the U.S., and alternative formulations which may be used to reduce or eliminate the CFC content of these products. The ban allowed for exemptions if it could be demonstrated that no acceptable alternative propellants were available and that the products were essential. Essentiality was based on three criteria: (1) the product's economic significance, (2) the environmental and health impacts of the product and its substitutes, and (3) the effects on the quality of life resulting from no longer having the product or a reasonable substitute available. Also, if a CFC served some purpose other than as a propellant, that product was excluded from the regulation. The study shows that about 40% of the CFC usage in these products can be immediately replaced by available substitutes. It identified seven categories of products for which immediate replacement of all of the CFC content is not technically feasible.

26625 (PB–90-150756/XAB) **Acidic-aerosol size distributions during SCAQS (Southern California Air Quality Study). Final report.** John, W.; Wall, S.M.; Ondo, J.L.; Winklmayr, W. California Dept. of Health Services, Berkeley, CA (USA). Air and Industrial Hygiene Lab. Nov 1989. 59p. (CA/DOH/AIHL/SP–51). Available from NTIS, PC A04/MF A01.

Ambient aerosol in the size range 0.075 - 16 micrometers was sampled with Berner cascade impactors during the summer and fall intensive sampling periods of the Southern California Air Quality Study (SCAQS) of 1987. Stage mass data were inverted by a modified version of the Twomey nonlinear iterative algorithm and modes in the inverted size distributions were fitted with lognormal functions. During SCAQS, most of the inorganic particle mass was in the droplet mode except during a period of exceptionally low relative humidity. Nitrate was internally mixed with sulfate in the droplet mode. Since most of the aerosol fine mass is included in the ions analyzed, the observed condensation and droplet modes characterize the overall size distribution in the 0.1-1 micrometer range, previously described by Whitby as a single accumulation mode.

26626 (PB–90-153867/XAB) **Simulation of high-altitude effects on heavy-duty diesel emissions. Final report, 31 October 1988-30 September 1989.** Human, D.M.; Ullman, T.L. Southwest Research Inst., San Antonio, TX (USA). Sep 1989. 94p. Available from NTIS, PC A05/MF A01.

Portions of this document are not fully legible.

Exhaust emissions from heavy-duty diesel engines operating at high altitude are of concern. EPA and Colorado Department of Health sponsored the project to characterize regulated and selected unregulated emissions from a naturally-aspirated Caterpillar 3208 and a turbocharged Cummins NTC-350 diesel engine at both low and simulated high altitude conditions (about 6000 ft). Emissions testing was performed over cold- and hot-start transient cycles as well as selected steady-state modes. Additionally, the turbocharged engine was operated with mechanically variable and fixed retarded fuel injection timing to represent normal and malfunction conditions, respectively. High altitude operation generally reduced NOx emissions approximately 10% for both engines. Average composite transient emissions of HC, CO, particulate matter, and aldehydes measured at high altitude for the naturally-aspirated engine were 2 to 4 times the levels noted for low altitude conditions. The same emission constituents from the turbocharged engine at high altitude with normal timing were 1.2 to 2 times the low altitude levels, but were 2 to 4 times the low altitude levels with malfunction timing.

26627 (PB–90-154683/XAB) **Collection efficiency of respirator filters challenged with monodisperse latex aerosols.** Brosseau, L.M.; Evans, J.S.; Ellenbecker, M.J.; Feldstein, M.L. Harvard Univ., Boston, MA (USA). School of Public Health. 1990. 25p. Available from NTIS, PC A03/MF A01.

An evaluation was made of the collection efficiency of electrostatically charged dust/mist respirator filters from ten manufacturers. Filters were challenged with eight sizes of latex spheres in a range which represents the silica (14808607) aerosol used in NIOSH certification tests. At or below the size of 0.102 micrometers, minimum efficiency was reported. Differences in the performance of the filters distributed by the ten manufacturers were noted. One manufacturer produced filters which were significantly lower in their collection efficiency than the other filters tested. Two manufacturers produced filters which were somewhat better than the other eight. By using a statistical evaluation of Weibull transformed data with analyses of covariance and Tukey's significant difference test it was possible to classify the filters into three performance groupings. Such filters were used in air purifying respirators designed for use in environments contaminated by moderately hazardous aerosols. The data collected not only served to assist in developing an empirical model, but also was helpful in the selection of a subset of filters for use in subsequent experiments.

26628 (PB–90-154691/XAB) **Collection of silica and asbestos aerosols by respirators at steady and cyclic flow.** Brosseau, L.M.; Ellenbecker, M.J.; Evans, J.S. Harvard Univ., Boston, MA (USA). School of Public Health. 1990. 36p. Available from NTIS, PC A03/MF A01.

Experiments were described which evaluated the predictive ability of tests using a silica aerosol under conditions of steady flow for determining respiratory efficiency. Measurements taken of silica penetration at steady flow were reasonably predictive of silica penetration under cyclic flow. Mass penetration of silica under continuous flow conditions was typically less than 0.1 percent. In general, the penetration of silica under conditions of cyclic flow was about one and a half times as great as that measured under steady flow conditions. However, the same was not true for testing with asbestos fibers under steady versus cyclic flow. Furthermore, the potential for exhalation valve failure under cyclic flow was also identified. The study indicates that these results call for a reevaluation of the current NIOSH protocols for evaluating respirator performance. The authors urge the development of a NIOSH testing method for evaluating the life cycle performance of respirator components such as exhalation valves.

26629 (PB–90-154915/XAB) **Regulatory impact analysis of air-pollutant emission standards and guidelines for municipal-waste combustors.** Robson, J.; Madariaga, B.; Walton, T. Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. Oct 1989. 171p. Available from NTIS, PC A08/MF A01.

The Environmental Protection Agency (EPA), under the authority of Clean Air Act 111(b) and (d), proposes to regulate air pollutant emissions from new and existing municipal waste combustors (MWCs). MWC emissions cause, or contribute significantly to, air pollution that endangers public health and welfare. The Standards and Guidelines require the reduction of emissions to the air of organic compounds (principally dioxins and furans), metals (cadmium, mercury, chromium, lead, nickel, etc.), acid gases (sulfur dioxide, hydrogen chloride, etc.), nitrogen oxides, and carbon monoxide. The Standards identify these pollutants as MWC emissions and nitrogen oxides. MWC emissions consist of MWC organics, MWC metals, and MWC acid gases. MWC emissions is the designated pollutant that triggers application of 111(d); the Guidelines do not address nitrogen oxides. Currently, EPA new source review permitting directives to the states recommend control of most of these pollutants at new, large MWCs.

26630 (PB–90-154923/XAB) **Municipal-waste combustion assessment: Combustion control at new facilities.** Schindler, P.J. Energy and Environmental Research Corp., Durham, NC (USA). Aug 1989. 70p. Available from NTIS, PC A04/MF A01.

See also PB–90-154931.

The EPA has completed an assessment of emission control performance and costs for add-on flue-gas-cleaning alternatives, and the results have been published in a technical support document as part of the 111(b) emission standards development effort for new municipal-waste combustors (MWCs). Twelve model plants were developed in the study to represent classes or groups of combustors in the new MWC population that will be subject to the standards. Baseline emission performance estimates were established for each of the model plants. A number of add-on control alternatives were applied to each model, and emission reduction and cost estimates were made for each control alternative. The report provides data and supporting rationale used to establish the baseline emission levels for each model plant.

26631 (PB–90-154931/XAB) **Municipal-waste combustion assessment: Combustion control at existing facilities.**

Schindler, P.J. Energy and Environmental Research Corp., Durham, NC (USA). Aug 1989. 107p. Available from NTIS, PC A06/MF A01.

See also PB–90-154923.

The EPA's Office of Air Quality Planning and Standards (OAQPS) is developing emission standards and guidelines for new and existing municipal waste combustors (MWCs) under the authority of Sections 111(b) and 111(d) of the Clean Air Act (CAA). The EPA's Office is providing support in developing the technical basis for good combustion practice (GCP), which is included as a regulatory alternative in the standards and guidelines. The report provides the supporting data and rationale used to establish baseline emission levels for model plants that represent portions of the existing population of MWCs. The baseline emissions were developed using the existing MWC data base or, in cases where no data existed, engineering judgement. The baseline emmissions represent performance levels against which the effectiveness and costs of emission control alternatives can be evaluated. The report provides the rationale used to estimate the emission reductions associated with each combustion retrofit.

26632 (PB–90-154949/XAB) **Municipal-waste combustion assessment: Technical basis for good combustion practice.** Schindler, P.J.; Nelson, L.P. Energy and Environmental Research Corp., Durham, NC (USA). Aug 1989. 108p. Available from NTIS, PC A06/MF A01.

The EPA's Office of Air Quality Planning and Standards (OAQPS) is developing emission standards and guidelines for, respectively, new and existing MWCs under the authority of sections 111(b) and 111(d) of the Clean Air Act (CAA). The EPA's Office of Research and Development (ORD) is providing support in developing the technical basis for good combustion practice (GCP), which is included in the regulatory alternatives considered in selecting the proposed standards and guidelines. The report defines GCP and summarizes the approach used to implement GCP into the proposed MWC standards and guidelines.

26633 (PB–90-155557/XAB) **Model of turbulent diffusion flames and nitric oxide generation.** Broadwell, J.E.; Tyson, T.J.; Kau, C.J. TRW Space and Technology Group, Redondo Beach, CA (USA). Jan 1990. 53p. Available from NTIS, PC A04/MF A01.

A new view is described of mixing and chemical reactions in turbulent fuel jets discharging into air. Review of available fundamental data from jet flames leads to the idea that mixing begins with a large scale, inviscid, intertwining of entrained air and fuel throughout the jet. Significant molecular mixing is delayed until the end of a cascade to the Kolmogorov scale. A simple mathematical model incorporating these ideas is presented. The model predicts a Reynolds number dependence for the nitric oxide formation rate that is in good agreement with measurements in both methane and hydrogen jets burning in air. These mathematical model concepts have been incorporated into a simplified computer program capable of treating the detailed chemical kinetics of a gas flame. The model has been used to predict NO formation in H2/air and CH4/air flames and results compare favorably with experimental data.

26634 (PB–90-155565/XAB) **Laboratory and field evaluations of methodology for measuring emissions of chlorinated solvents from stationary sources. Project report.** Carver, A.C.; DeWees, W.G.; Coppedge, E.A. Entropy Environmentalists, Inc., Research Triangle Park, NC (USA). Feb 1990. 91p. Available from NTIS, PC A05/MF A01.

Several chlorinated solvents are being evaluated for future emission regulations by the U.S. Environmental Protection Agency (EPA). Many state and local agencies already regulate chlorinated solvents. Therefore, measurement methodologies for these compounds should be investigated. Entropy was commissioned by the Quality Assurance Division of EPA's Atmospheric Research and Exposure Assessment Laboratory to perform laboratory and field studies to evaluate sampling and analytical techniques for the measurement of carbon tetrachloride (CCl4), chloroform (CHCl3), perchloroethylene (PERC), and trichloroethylene (TCE) emissions from stationary sources. The studies were conducted in two phases: preliminary work and field studies evaluating EPA Method 18 when applied to the emissions of PERC from degreasing facilities and laboratory and field studies evaluating modified EPA Method 18 sampling procedures for collection of all four chlorinated solvents under high temperature and high moisture conditions.

26635 (PB–90-155573/XAB) **Characterization of population and usage of unvented kerosene space heaters. Final report, May 1988-January 1989.** Barnes, J.; Holland, P.; Mihlmester, P. Applied Management Sciences, Inc., Oak Ridge, TN (USA). Jan 1990. 75p. Available from NTIS, PC A04/MF A01.

The report gives results of a study of the market penetration of unvented kerosene space heaters (UKSHs) in the residential sector. The study was aimed at gathering baseline information to help assess the magnitude and potential severity of a problem involving emissions from unvented appliances, one of a number of synergistic factors affecting indoor air quality. UKSHs can be a significant source of such emissions. UKSH usage patterns were also investigated. Annual sales of UKSHs are estimated at 825,000 units. Leading brands include convective units marketed by Toyotomi USA (kero-Sun) and Corona USA. Some units contain built-in catalytic filters for odor control. Add-on catalytic filters are available from at least one manufacturer. It is believed that 15-17 million portable UKSHs have been sold in the U.S. since the early 1970s. However, it is estimated that, in the 1986-87 heating season, there were only about 7 million units in use. About half of these units are in the South. Depending on whether UKSHs are used as primary or secondary heating sources, they may be used anywhere from 1 to 17 hours a day. Eighty percent of UKSHs are used in multifamily dwellings and mobile homes.

26636 (PB–90-155664/XAB) **Low NOx strategy for combusting high-nitrogen-content fuels. Final report, November 1984-July 1987.** Srivastava, R.K. Acurex Corp., Research Triangle Park, NC (USA). Environmental Systems Div. Jan 1990. 72p. Available from NTIS, PC A04/MF A01.

The report gives results of an evaluation of a multistaged combustion burner (designed for in-furnace NOx control and high combustion efficiency) for high nitrogen content fuel and waste incineration application in a 1.0 MW package boiler simulator. A low NOx precombustion chamber burner has been reduced in size by about a factor of two (from 600 to 250 ms first-stage residence time) and coupled with air staging, resulting in a three-stage configuration, and natural gas fuel staging, yielding up to four stoichiometric zones. Natural gas, doped with ammonia to yield a 5.8% fuel nitrogen content, and distillate fuel oil, doped with pyridine to yield a 2.0% fuel nitrogen content, were used to simulate high nitrogen content fuel/waste mixtures. Under the conditions tested, net chemical destruction of NO via reburning does not seem to be evident. This may be due to the existence of rather low primary NO concentrations before the application of reburning. However, a beneficial dilution caused by reburning may provide lower NO emissions.

26637 (PB–90-156985/XAB) **Methods for measuring lead concentrations in paint films.** McKnight, M.E.; Byrd, W.E.; Roberts, W.E.; Lagergren, E.S. National Inst. of Standards and Technology, Gaithersburg, MD (USA). Dec 1989. 123p. (NISTIR–89/4209). Available from NTIS, PC A06/MF A01.

Recent legislation required the U.S. Department of Housing and Urban Development (HUD) to establish procedures to abate lead-based paint in existing HUD-assisted housing. The legislation also required HUD to assess the accuracy, precision, reliability, and safety of methods for measuring lead content of paint films and to investigate the availability of testers and samplers. The National Institute of Standards and Technology was requested to carry out the assessment. With regard to accuracy and precision of field measurements, it was concluded that: chemical spot tests when carried out by an experienced analytical chemistry technician can detect the presence of lead in paint films having concentrations in excess of 1 mg/sq cm about 90% of the time; the estimate of the precision of a field measurement procedure using lead-specific portable X-ray fluorescence (XRF) analyzers for lead concentrations near 1 mg/sq cm is + or - 0.6 mg/sq cm and the estimate of the bias is 0.2 mg/sq cm; this results in a 95% confidence interval of + or - 1.4 mg/sq cm; and based upon very preliminary measurements using the latest version of the spectrum analyzer portable XRF, the 95% confidence interval for field measurements is estimated to be + or -

0.5 mg/sq cm. In addition to field methods, standard laboratory procedures can be used to measure the lead content of paint samples to within a few percent of the quantity present over a wide range extending from less than 0.1 to over 10 mg/sq cm. Sample collection and sample dissolution procedures were also investigated.

26638 (PB–90-157496/XAB) **Effects of acid fog and dew on materials. Final report.** Mansfeld, F.; Henry, R.; Vijayakumar, R. University of Southern California, Los Angeles, CA (USA). Oct 1989. 90p. Available from NTIS, PC A05/MF A01.

Field exposure tests have been carried out in order to separate the effects of acidic fog on materials damage from those caused by rain, dew and natural weathering. The test sites were McKittrick and Visalia in the Central Valley and West Casitas Pass in Ventura County. The field tests have been supported by laboratory tests in which materials damage has been determined during exposure to carefully controlled fog water chemistry. Analysis of the field exposure results for galvanized steel and the paint samples shows that the corrosivity of the atmosphere at the three test sites have been very low. The result is confirmed by the ACRM data which show very low corrosion activity. Since corrosion rates were so low approaching those for natural weathering, it was not possible to determine the effects of acidic fog. Based on the aerometric data and the observed corrosion behavior, it is doubtful that acidic fog conditions prevailed for significant times during the exposure period of 1/87 - 3/88 at Visalia and McKittrick. The results of the laboratory tests show that exposure to HNO3 at low pH and to high pollutant concentration increased the corrosion rate of galvanized steel to over 10 micro m/year. Exposure to HNO3 caused serious corrosion damage to anodized aluminum and the paint.

26639 (PB–90-158973/XAB) **Investigation of the effects of acid deposition on materials. Final report.** Vijayakuma, R.; Mansfeld, F.; Henry, R. Environmental Monitoring and Services, Inc., Camarillo, CA (USA). Oct 1989. 165p. Available from NTIS, PC A08/MF A01.

The objective of the project was to determine damage functions which relate the atmospheric corrosion losses to the concentration of the pollutants which are routinely monitored. The materials investigated in the study were chosen based on the economic importance and included galvanized steel, nickel, aluminum, two types of flat latex exterior housepaint, nylon fabric, polyethylene and concrete. Atmospheric data were provided by ARB's air monitoring network at the three test sites in Southern California. The results from the field sites have been supported by laboratory tests in which corrosion damage was determined. The samples were exposed to SO2, NO2, or O3 and the combinations and to HNO3 aerosol of two different concentrations and flow rates. Corrosion rates determined by weight loss for galvanized steel, nickel, aluminum and latex paint containing some carbonate extender were higher in the summer than in the winter despite the fact that moisture and primary pollutant levels are higher in the winter. The corrosion rates for galvanized steel which has served as a benchmark material in most atmospheric exposure tests were very low and similar to rates which are usually observed at clean, rural areas. Damage functions were determined by regression of the corrosion rates against the explanatory variables which in the study were O3, NO2, T60, O3xT60, NO2xT60 and O3xNO2 averaged over the exposure T60 is the time for which the RH exceeded 60%.

26640 (PB–90-159450/XAB) **Aircraft measurements of pollution species near Bermuda and the east coast of the United States during CASE-WATOX. Technical memo.** Gunter, R.L.; Boatman, J.F. National Oceanic and Atmospheric Administration, Boulder, CO (USA). Oct 1989. 67p. (NOAA-TM-ERL-ARL–176). Available from NTIS, PC A04/MF A01.

Chemical, meteorological, and aerosol measurements were made with the NOAA King Air C-90 aircraft during July 1988 near Bermuda and the east coast of the U.S. The study extended the 1985 and 1986 Western Atlantic Ocean Experiment (WATOX) and initiated coordinated aircraft and ship measurements, following the design of the Coordinated Air Sea Experiment (CASE), in which flights were planned to be made in the vicinity of the NOAA ship Mt. Mitchell. The report lists the objectives of the CASE-WATOX program; the instrumentation used, and the data obtained with the aircraft; a general outline of ship and aircraft coordination and instrumentation; and the aircraft data processing, quality and availability.

26641 (PB–90-159898/XAB) **Design report: Low NOx burners for package boilers. Final report, May 1985-March 1989.** Brown, R.A.; Dehne, H.; Eaton, S.; Mason, H.B.; Torbov, S. Acurex Corp., Mountain View, CA (USA). Environmental Systems Div. c Jan 1990. 142p. Available from NTIS, PC A07/MF A01.

The report describes a low-NOx burner design, presented for residual-oil-fired industrial boilers and boilers cofiring conventional fuels and nitrated hazardous wastes. The burner offers lower NOx emission levels for these applications than conventional commercial burners. The burner utilizes two-stage combustion in a deep staging mode in which a precombustor firing substoichiometrically is retrofitted to the front of the boiler. The completion of the combustion in the second stage is achieved through sidefire air ports to be retrofitted to the boiler. The precombustor is a cylindrical shell of 2.1 m internal diameter fabricated of lightweight refractory blocks with a Saffil based coating. This material gives a lightweight, nonregenerative precombustor which can adapt to the start-up, shutdown, and load following transients typical of industrial boilers. The precombustor is designed for the capacity range of 15-29 MW heat input. A modular design using annular spool sections adapts to different design loads within this range. For larger loads, a geometric scale-up is required. Design data are also given for 59 MW capacity.

26642 (PB–90-160045/XAB) **Running loss evaporative emissions determination by the point-source method. Technical report (Final).** National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). 17 Oct 1989. 45p. Available from NTIS, PC A03/MF A01.

The work examined the potential of determining running emissions by examining the sources of evaporation of fuel from a vehicle during operation. This required the use of equipment based on constant volume sampling with multiple sources that could simultaneously monitor different locations. The hydrocarbon emissions were measured for their total content with two California certified vehicles. The operating temperature and fuel vapor pressure were control variables that were examined for their effect. Evaporative running losses were found at the charcoal canister and purge air vent. Differences in the losses were observed with the two vehicles. The fuel vapor pressure and driving cycle were major factors over the ranges examined, but temperature had statistical significance. A model used to predict vapor generation from the fuel was in general agreement with the running loss experimental data.

26643 (PB–90-160938/XAB) **Investigation of the effects of fuel composition and injection and combustion system type on heavy-duty diesel exhaust emissions. Final report.** Ullman, T.L. Southwest Research Inst., San Antonio, TX (USA). Mar 1989. 322p. (SWRI–8673). Available from NTIS, PC A14/MF A02.

Dynamometer tests on 3 heavy-duty diesel engines supplied by their manufacturers, using the EPA transient emission test cycle and smoke procedure, and under steady-state conditions differing in speed and load, were conducted. Exhaust pollutants measured with each fuel/engine/operating mode combination included total particulate, its solvent extractable portion, total hydrocarbon, NOx, CO, benzene, and sulfate emissions, along with fuel consumption. Visible smoke was measured during the Federal smoke test only. In addition, total particulate was measured on a modal basis, and low-humidity particulate emission determinations were made for selected fuels. EPA performed elemental and organic carbon analyses of selected particulate samples. The original set of several test fuels consisted of specially blended fuels having varying levels of aromaticity, sulfur content, and 90% distillation temperature. Two additional fuels (low-sulfur, low-aromatic and low-sulfur, high-aromatic) were made by reprocessing specific mixtures of the original fuel set.

26644 (PB–90-161514/XAB) **Chromium emissions from comfort cooling towers: Background information for promulgated standards. Environmental impact statement (Final).** Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. Jan 1989. 90p. (EPA–450/3-87/010B). Available from NTIS, PC A05/MF A01.

See also PB–88-197298.

A final rule for the control of hexavalent chromium emissions from comfort cooling towers (CCT) is being promulgated under authority of Section 6 of the Toxic Substances Control Act. The final rule prohibits both the use of Cr(+6) in CCTs and the distribution in commerce of CR(+6) for use in CCTs. The rule would apply to existing and new CCTs. The document contains a summary of changes to the rule made since proposal, a summary of the impacts of the promulgated rule, and a summary of the public comments on the proposed rule and EPA's responses.

26645 (PB–90-161688/XAB) **Options for controlling the global-warming impact from motor vehicles. Technical report.** Heavenrich, R.M.; Murrell, J.D.; Hellman, K.H. Environmental Protection Agency, Ann Arbor, MI (USA). Dec 1989. 23p. (EPA/AA/CTAB–89/08). Available from NTIS, PC A03/MF A01.

There is a great deal of interest in the subject of global warming and potential ways to mitigate the impacts of emissions that contribute to global warming. The paper discusses ways to formulate approaches that could be involved in a regulatory program for control of carbon dioxide emissions from cars and light trucks.

26646 (PB–90-501115/XAB) **Surface Impoundment Modeling System (SIMS), Version 1.0 (for microcomputers). Software.** Misenheimer, D.C. Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. Sep 1989. v. Available from NTISCP D01.

The software is contained on 5 1/4-inch diskettes, double density (360K), compatible with the IBM PC microcomputer. The diskettes are in the ASCII format. Price includes documentation, PB–90-141227 and PB–90-141235.

The Surface Impoundment Modeling System (SIMS) is a personal computer program designed to estimate air emissions from surface impoundments. The emission estimates are based on mass transfer models developed by the Emissions Standards Division of the Environmental Protection Agency during the evaluation of hazardous waste treatment, storage, and disposal facilities. SIMS allows the user to specify all the required inputs to these emission models when the information is available, or when only limited information is available, provides default values for most of the model inputs...Software Description: The software is written in the C programming language for implementation on an IBM PC or compatible.

26647 (PB–90-501222/XAB) **MOBILE4 emission factor model: Source code (one version mixed case, one version upper case), input files for example runs, and high-altitude area l/m credits (for PS2 or 80386 chip microcomputers). Model.** Newell, T.; Kahlbaum, D. Environmental Protection Agency, Ann Arbor, MI (USA). Motor Vehicle Emission Lab. Jan 1990. v. Available from NTISCP D99.

See also PB–89-170211. The model is contained on 5 1/4-inch diskettes, high density (1.2M), compatible with the IBM PS/2 microcomputer. The diskettes are in the ASCII format. Price includes documentation, PB–89-164271.

MOBILE4 is a computer program that calculates emission factors for hydrocarbons, carbon monoxide, and oxides of nitrogen from highway motor vehicles. MOBILE4 calculates emission factors for eight individual vehicle types in two regions of the country (low- and high-altitude). The emission factors depend on various conditions such as ambient temperature, fuel volatility, speed, and mileage accrual rates. MOBILE4 will estimate emission factors for any calendar year between 1960 and 2020 inclusive. The 20 most recent model years are considered in operation in each calendar year. MOBILE4 supercedes MOBILE3. Relative to MOBILE3, MOBILE4 incorporates several new options, calculating methodologies, emission control regulations, and internal program designs. The software is written in the FORTRAN 4.01 language for use on an IBM PS/2 or compatible machine using MS-DOS 4.0+ operating system. It requires a minimum of 640K of memory.

26648 (PB–90-857251/XAB) **Aerosol size distribution and classification. February 1970-January 1990 (Citations from the NTIS data base). Report for February 1970-January 1990.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 121p. Available from NTISPC N01/MF N01.

Supersedes PB–86-873809.

This bibliography contains citations concerning aerosol size distribution and classification pertaining to air pollution detection and health studies. Aerosol size measuring methods, devices, and apparatus are discussed. Studies of atmospheric, industrial, radioactive, and marine aerosols are presented. (This updated bibliography contains 226 citations, 80 of which are new entries to the previous edition.)

26649 (PB–90-857426/XAB) **Indoor air pollution: Sources and control. July 1988-January 1990 (Citations from the NTIS data base). Report for July 1988-January 1990.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 52p. Available from NTISPC N01/MF N01.

Supersedes PB–89-866834.

This bibliography contains citations concerning indoor air pollution in residential, commercial, industrial, and institutional buildings. Indoor air quality assessment, health hazard evaluation, and contaminant identification and measurement are discussed. Indoor air pollution control methods and equipment are evaluated. Air quality analyses of energy efficient buildings are presented. Indoor air pollution from radon and asbestos are discussed in other bibliographies. (This updated bibliography contains 75 citations, 16 of which are new entries to the previous edition.)

26650 (PB–90-858408/XAB) **Chlorofluorocarbons (CFC's): Regulation and replacement. June 1981-January 1990 (A Bibliography from the Paper and Board, Printing, and Packaging Industries Research Associations data base). Report for June 1981-January 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 76p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning chlorofluorocarbons (CFC's), and efforts to find substitute materials in response to the need to lessen the environmental impact of CFC on the ozone layer, as agreed to in the international Montreal Protocol. CFC alternatives are expected to be used as aerosol propellants, blowing agents, refrigerants, fire extinguishants, and solvents. References to the effects of CFC on ozone are found in separate Published Searches. (Contains 112 citations fully indexed and including a title list.)

26651 (PB–90-859380/XAB) **Air pollution control equipment: Catalytic converters. January 1983-December 1989 (A Bibliography from the COMPENDEX data base). Report for January 1983-December 1989.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 75p. Available from NTISPC N01/MF N01.

Supersedes PB–89-853519.

This bibliography contains citations concerning the use of catalytic converters for automotive emission control. The cracking of hydrocarbons and the removal of sulfur and nitrogen oxide are emphasized. The effects of elevated temperatures on the creep properties of stainless steels used in catalytic converters are also included. (This updated bibliography contains 139 citations, 31 of which are new entries to the previous edition.)

26652 (PNL-SA–16399) **Global carbon emissions control: The role of US energy-efficiency policy.** Chandler, W.U. (Pacific Northwest Lab., Washington, DC (USA)). Pacific Northwest Lab., Richland, WA (USA). Nov 1988. 34p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-8811318–1: IIASA energy conference, Laxenburg (Austria), 15 Nov 1988). Order Number DE90009170. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Recent events in the United States have placed global climatic change on the national policy agenda. Events and public sentiment have led to the introduction of major legislation to control greenhouse gas emissions, and Congress has mandated several major studies to assess means of controlling emissions. The policy responses the United States will ultimately make could have an impact beyond their direct reduction of greenhouse gas emissions. The United States is the leading source of anthropogenic carbon dioxide, and it is unlikely that the international community can act together to cut carbon emissions unless the United States makes a serious effort to do so. This document discusses the US energy and

carbon intensity, additional opportunities for efficiency and energy policies for continuing US efficiency gains. 41 refs., 9 figs., 4 tabs.

26653 (SIS–1989:5) **An evaluation of passive methods for measurement of radon in dwellings.** Strand, T.; Lind, B.; Kolstad, A.K. Statens Inst. for Straalehygiene, Oslo (Norway). 1989. 47p. (In Norwegian). Order Number DE90622943. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

During the last ten years, different methods have been developed for the measurement of radon in indoor air. In this report the different methods in use by private firms in Norway have been compared. The results of the study show that the methods are quite different in regard to integration time, detection limit and reliability in measurements of radon in indoor air. In 1988 the National Institute of Radiation Hygiene gave directives on the performance of such measurements. In these directives, minimum limits have been set for integration time (7 days) for methods to be used in evaluations of remedial actions. In this report the results from a simple, anonymeous reliability test are reported. The test covered the private firms offering radon meassurement services in Norway. The frequently reported weaknesses by the charcoal method were confirmed in the study. The directives on radon measurements in dwellings are presented. 73 refs.; 11 figs.; 5 tabs.

26654 (UCRL–102132) **Human exposure through food chains: Uncertainities and research needs.** McKone, T.E. Lawrence Livermore National Lab., CA (USA). Feb 1990. 29p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900208–2: American Association for the Advancement of Science annual meeting, New Orleans, LA (USA), 15-20 Feb 1990). Order Number DE90009032. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Using information collected under the "community right to know" provision of the Superfund reauthorization act, the US Environmental Protection Agency has revealed that some two to three billion pounds of toxic chemicals are released annually to the atmosphere from industries in the US. Human populations can contact these environmental pollutants through food, water, and air in varying amounts each day throughout a lifetime. A realistic strategy for managing the potential health risks of industrial emissions requires a comprehensive approach with adequate attention to uncertainties. Using contaminant transfers from air to milk and as a case study, I consider here two important issues in exposure assessment — (1) estimation of and (2) reduction of uncertainty in exposure estimates. This case study provides a distinction between variability, ignorance and uncertainty. For the air/milk pathways, I explore the use of exposure models that combine information on environmental partitioning with data on human diet, behavior patterns, and physiology into a numerical expression that links ambient air concentrations with chronic daily intake. I examine how uncertainty limits current exposure modeling efforts and suggest research to reduce these uncertainty. 17 refs., 12 figs., 1 tab.

26655 (Vejdatalaboratoriet-R–62) **Skaerbaek: Effects of a through-road having been constructed according to environmental values. Pollution effects. Noise and air pollution, vibrations and energy consumption.** Bendtsen, H. (ed.). Vejdirektoratet, Copenhagen (Denmark). Vejdatalaboratoriet. 1989. 100p. (In Danish). Available from Available on loan from Risoe Library, DK-4000 Roskilde.

The aim was to reconstruct the road passing directly through Skaerbaek in Denmark in such a way that vehicles were forced to reduce speed, and thus the quality of the environment for pedestrians and cyclists could be increased. It was expected that these innovations would result in more frequent braking and acceleration which would add to air and noise pollution and could cause vibration in nearby buildings. The extent of these forms of environmental pollution has been measured and it is concluded that the motion pattern of the vehicles was more even, and that generally the levels of pollution were not increased, with the exception of noise pollution. (AB) 13 refs.

26656 (WSL-LR–716(PA)M) **Review of potential acid gas abatement technologies for small combustion plant.** Giddings, T.J. Warren Spring Lab., Stevenage (UK). Mar 1989. 23p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

It has been recognised for many years that atomospheric pollutants such as SO_2, NO_x and HCl have a detrimental effect on the environment. As scientific evidence and public awareness have increased, it has been necessary to formulate and begin to introduce legislation to regulate emission levels from combustion plant and mobile sources. There has been increasing pressure to extend the regulations to control emissions from small combustion plant (<50 MW thermal). The present work was initiated to review various technologies available which could be used for pollution abatement in small combustion plant. Fuel additives can be incorporated into the fuel directly during combustion, alternatively, compounds can be injected into the furnace or used in a fluidised bed. Post combustion control essentially involves wet or dry scrubbers. Wet scrubbers give poor plume buoyance, and additional problems arise, with treatment and disposal of waste and a requirement for large volumes of water. (author).

26657 **Policy keynote speech of ambassador.** pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This presentation discusses preventive measures and collaborative activity to deal with the menace of global warming. Recent changes in the Soviet approach to international issues are discussed. Utilization of the United Nations to deal with the climate change is suggested as a useful approach. Commitment of both developed and undeveloped countries is stressed. The June 1988 Toronto conference and its plan for dealing with the changing atmosphere is outlined. (1) A reduction in carbon emissions. (2) Establishment of a World Atmosphere Fund derived from a surcharge on the purchase and use of fossil fuels. (3) Massive reforestation efforts. (4) Global atmosphere convention. (5) Increase in research and development. (6) Ratification of the Ozone protocol. The serious state of socio-economic conditions in developing countries are presented as obstacles to overcome.

26658 **Concluding address by Senator Albert Gore, Jr.** pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper presents some aspects of global warming evidence in the Antarctica. International participation requires political action and leadership. An Ambassador-at-large should coordinate international type activities. Some obstacles are discussed.

26659 **Opening speech of Joseph A. Cannon.** pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

An overview of the conference deliberations on greenhouse warming and stratospheric ozone depletions is given. Previous international efforts to bring focus on these issues are highlighted. The collaboration of governments and industry is deemed critical.

26660 **Remarks of Robert Grady.** pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The president elects views are provided by the administration transition team and with their perspectives. Dealing with the environmental issues requires commitments.

26661 **US-USSR cooperation in climate studies.** Hecht, A.D. (National Climate Program Office, Rockville, MD (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The US-USSR scientific cooperation in the field of climate studies since 1974 is highlighted.

26662 The Montreal ozone protocol: Lessons for global warming. Benedick, R.E. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

At Montreal, nations agreed for the first time on a worldwide regime for specified reductions of potentially damaging chemicals, through preventive measures. The ozone protocol serves as a prototype for new diplomatic approaches to emerging global issues. Analysis of these elements are presented for insights into a possible methodology for dealing with climate change on an international level.

26663 UNEP's (United Nations Environment Program) role in addressing climate change. Brown, N. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The United Nations General Assembly adoption of a resolution protecting climate for present and future generations is discussed. The resolution sought to mobilize action in all sectors of the international community, in particular to promote ratification of the Montreal Protocol. Five steps to implement the protocol are briefly outlined: (1) Accelerate the state of knowledge of the signs of climate change to promote consensus. (2) Embark on programs and studies on the social and economic impact of climate change. (3) Provide possible response strategies to delay or mitigate adverse impacts. (4) Identify and strengthen related international legal instruments. (5) International convention on climate change. Actions underway are examined.

26664 Agenda for the next decade: Canadian perspectives. Dawson, D.K. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The Canadian perspective reflects the results of the Toronto meeting and the results of an active domestic research effort under the Climate Control Program, which also participates in the World Climate Program. A four point program is proposed as the agenda for next decade: (1) Placing particular emphasis on understanding the global climate system, and the sensitivity of society to changes within it. (2) Develop appropriate strategies to adapt to possible changes by addressing the question of uncertainty and including it the assessment of risks and costs. (3) Provide focus on international conventions and protocols, strengthening those in existence and adding new ones to fill the major gaps. (4) Make effective transfer of information to the general public.

26665 The greenhouse effect: Reality or media event. Schneider, S.H. (National Center for Atmospheric Research, Boulder, CO (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

In 1988, The Environment became a media event rivaling politics and sports. The greenhouse effect, despite the controversy, is actually one of the most well-accepted and well-documented theories in the atmospheric sciences. The controversy begins to build though, when we have to translate extra heating of the Earth's surface in the future scenarios of climate changes. Evidence of some climate changes with some possible related events and impacts are presented. The news media dilemma in relating spectacular events in nature with scientifically sound conclusions is discussed.

26666 Regional greenhouse climate effects. Hansen, J. (NASA Goddard Institute for Space Studies, NY (USA)); Rind, D.; DelGenio, A.; Lacis, A.; Lebedeff, S.; Prather, M.; Ruedy, R.; Karl, T. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

We discuss the impact of an increasing greenhouse effect on three aspects of regional climate: droughts, storms and temperature. A continuation of current growth rates of greenhouse gases causes an increase in the frequency and severity of droughts in our climate mode simulations, with the greatest impacts in broad regions of the subtropics and middle latitudes. The greenhouse effect enhances both ends of the hydrologic cycle in the model, i.e., there is an increased frequency of very wet situations, and increased drought. Model results shown imply that increased greenhouse warming will lead to more intense thunderstorms, that is, deeper thunderstorms with greater rainfall. Emanuel has shown that the model results also imply that the greenhouse warming leads to more destructive tropical cyclones. We present updated records of observed temperatures and show that the observations and model results, averaged over the globe and over the United States, are generally consistent. Finally, we quantify recent greenhouse climate forcings, showing, for example, that chlorofluorocarbons have grown to be 25 percent of current increases of the greenhouse effect. The impacts simulated of climate changes on droughts, storms and temperature provide no evidence that there will be regional winners if greenhouse gases continue to increase rapidly. 30 refs., 11 figs.

26667 Luncheon panel on stratospheric ozone depletion December 6, 1988. Rowland, F.S. (Univ. of California, Irvine (USA)); McElroy, M.; Watson, R.; Chisholm, A. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Ozone has been steadily depleting since probably the mid-1970s in Antarctic. Monitoring has indicated very high levels of chlorine monoxide and a very highly disturbed atmosphere. Bromine compounds are now also considered to be a significant factor, all though they represent a small percentage of the contribution. Results of the National Aeronautic Space Administration monitoring for the Ozone Trends Panel are presented. The ozone monitoring of the Arctic regions is also discussed.

26668 Airborne Arctic stratospheric expedition preliminary findings. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The chemical composition of the Arctic polar stratosphere is highly perturbed. The preliminary results of the mission have substantially increased confidence in the scientific understanding of the Polar Stratospheric Cloud-induced, chlorine catalyzed, ozone depletion phenomenon. Tentative summary conclusions are given.

26669 Climate impacts of methane clathrates. MacDonald, G.J. (MITRE Corp., McLean, VA (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

During periods of continental glaciation, concentrations of atmospheric carbon dioxide and methane were two-thirds and one-half lower, respectively, than the values that prevailed during interglacial and post glacial periods. These compositional changes represent the transfer of about 200 Gt of carbon into and out of the atmosphere. The decrease in atmospheric carbon took place gradually over 100,000 years, while the buildup of carbon dioxide concentration required only a few thousand years. Changes in the levels of these two infrared-absorbing gases provide a positive feedback to alterations of earth's radiation budget associated with the earth's orbital fluctuations. Conventional representations of the carbon cycle identify three major reservoirs of carbon-oceans, fossil fuels, and soils. Methane clathrates are suggested to form a fourth major reservoir; one that is sensitive to surface disturbances of temperature and pressure–brought about by ice cap growth and dissipation–and the accompanying fall and rise of sea level. The possibility that large quantities of carbon can be stored in

clathrates is a recent discovery which has not yet been fully explored for consequences for past and future climates. 8 figs.

26670 The dynamic greenhouse: Feedback processes that can influence global warming. Lashof, D.A. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper assess the significance of those feedbacks that have the potential to play an important role in the intermediate-term (within about a century). Each of the feedbacks seem modest when compared to water vapor feedback, the biogeochemical feedbacks in combination have substantial potential to increase the climate change. This analysis indicates the relative magnitude of various feedback processes, suggesting that methane hydrates, ocean mixing and circulation, and vegetation albedo, may be the most important ones. 47 refs., 1 tab.

26671 Future changes in climate variability. Rind, D. (Goddard Space Flight Center, NY (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

An overview and summary of a previously conducted in-depth study is presented. The study results study were that: temperature variability decreased and hydrologic variability increased as the climate warmed. 6 refs.

26672 Implications of urbanization for local and regional temperatures in the United States. Viterito, A. (George Washington Univ., Washington, DC (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

It was known in medieval times that urban areas significantly modified their local climates. A large body of empirical and theoretical evidence suggests that urban areas are warmer than their rural counterparts, have enhanced rainfall amounts, are generally less humid, and have reduced wind speeds. Urban air quality is also significantly poorer. The situations in some large urban areas are discussed. 4 refs., 1 fig., 3 tabs.

26673 Potential shifts of monsoon patterns associated with climate warming. Rasmusson, E.M. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

On balance, general circulation model results to date give a tenuous indication that a global warming would result in a general increase in summer monsoon precipitation. Not all models agree, and in any event, model deficiencies make these early results highly preliminary and far from conclusive. Simulations derived from models with an improved hydrologic cycle and a better ocean component are needed. 7 refs.

26674 Understanding El Nino and other long-term climate variability over the oceans. Diaz, H.F. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

An important part of the process associated with early detection of climate change and the development of plausible regional climate change scenarios involves a determination of the range of past patterns of climatic variability from the observational record and understanding of its causal mechanisms. Understanding the role of the oceans in forcing inter annual and longer time-scale climate variability is critical in this regard. Two types of phenomena are examined. One is the El Nino/Southern Oscillation phenomena and the other deals with low frequency variability of sea surface temperatures, principally over the Atlantic and Pacific oceans. 9 refs., 5 figs.

26675 The Atlantic Ocean: Unsung partner in global climate change. Molinari, R.L. (National Oceanic and Atmospheric Administration, Miami, FL (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The Atlantic ocean seems to be a major player in establishing global climate change. The present understanding of the Atlantic's role in climate change is much less developed than in the case of the Pacific. A summary is given of the relation between climate and the Atlantic and an implicit argument that our present knowledge is sufficient to warrant more intensive research in the basin. 11 refs.

26676 Oceans: A dynamic reservoir for carbon dioxide. Takahashi, T. (Columbia Univ., Palisades, NY (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper discusses the major processes governing the oceanic CO_2 reservoir capacity and their influence to the atmospheric CO_2 concentration, with a course for future scientific research. 5 refs., 3 figs.

26677 Overview of the potential effects of climate change on human health. Longstreth, J. (Clement Associates, Fairfax, VA (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

An overview is given of a report prepared by the Environmental Protection Agency for Congress. There are many interrelationships between weather and human health effects. Generally weather patterns do not directly induce mortality, but rather it sets up a situation where mortality is more likely. In the US, the modeling analyses performed for the report to Congress suggest that global warming will have a net adverse impact on human mortality. More research is needed. 11 refs., 3 figs.

26678 Climate change and parasitic diseases of man and domestic livestock in the United States. Dobson, A. (Univ. of Rochester, NY (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper briefly discusses some general properties of parasites and how climate change might effect the seasonal incidence of three important veterinary parasites and the possible introduction of several human parasites. 15 refs, 2 figs., 2 tabs.

26679 Potential impact of global warming: Changes in mortality from extreme heat and cold. Kalksten, L.S. (Univ. of Delaware, Newark (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The objective of this study is to evaluate changes in human mortality attributed to predicted changes in climate due to increased concentrations of CO_2 and other trace gases in the atmosphere. In addition, the historical relationships between weather and mortality are evaluated, and those weather variables most influential upon summer and winter mortality are identified. Finally, briefly discussed are the results from a preliminary study to determine the differential impact of weather and pollution mortality in St. Louis. 4 refs., 1 tab.

26680 Climate change as natural hazard: Three perspectives from natural hazards research useful for analyzing the social implications of global warming. Riebsame, W.E. (Univ. of Colorado, Boulder (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Hazards researchers and managers have developed considerable understanding of social systems under environmental stress, and some aspects of this experience can be usefully applied to climate change. Though the focus of hazards work has been on short-duration, extreme events rather than cumulative environmental changes, it provides at least three useful perspectives on the interaction of society and changes in the climate: (1) Hazards theory explicitly analyzes the interaction of natural and social systems in an ecological framework; (2) Hazards researchers recognize that people respond to the environment perceived, rather than as defined by physical science; and (3) even slow, cumulative climate changes may be interpreted and responded to as discrete extreme events. 14 refs, 3 figs.

26681 Overview of the potential health effects associated with ozone depletion. Longstreth, J. (Clement Associates, Fairfax, VA (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The stratospheric ozone layer acts as a protective shield, preventing much of the sun's ultraviolet radiation (UVR) from hitting the earth. The Environmental Protection Agency evaluated the hazards associated with UV-B exposure, which is only partially absorbed, and estimated the health risks associated with decreases in the ozone layer. A summary of the risk assessment is given. 16 refs., 2 figs.

26682 Stratospheric ozone depletion, sunlight and immune suppression. A new connection. De Fabo, E.C. (George Washington Univ. Medical Center, Washington, DC (USA)); Noonan, F.P. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The summary results cover research in photoimmunology and the discovery of a unique photoreceptor (PR) found on human and mammalian skin. This photoreceptor is capable of mediating interaction between sunlight and the immune system. This interaction is able to occur without direct irradiation on circulating blood cells, meaning that whatever solar UV-B is doing, it must be occurring in the outermost layers of skin. The UV-B radiation is directly converted by this PR, into biochemical energy capable of interaction with the immune system. The resultant end product product is the formation of a very specific type of immune cell, known as suppressor T cells, which are discussed in some detail. 17 refs.

26683 Implication of ultraviolet light in skin cancer and eye disorders. Kornhauser, A. (Food and Drug Administration, Washington, DC (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Some implications of the potential UV-B radiation increase, due to ozone depletion, to the incidence of skin cancer in humans are briefly discussed. This paper concentrates on the health effects. Education of the population is urged to reduce the risks of over exposure. 3 refs.

26684 The impact of climatic change on agriculture. Parry, M.L. (Univ. of Birmingham (England)); Carter, T.R. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Changes in the composition of the earth's atmosphere will have direct effects on agriculture and also indirect climatic effects. This paper focuses on the climatic effects and provides a brief summary of some methods and results of a detailed study. Outlined is a partially integrated approach for assessing climatic change impacts on agriculture. 11 refs.

26685 Likely effects of climate change scenarios on agriculture of the USA. Allen, L.H. Jr. (Univ. of Florida, Gainesville (USA)); Peart, R.M.; Jones, J.W.; Curry, R.B.; Boote, K.J. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The following areas are briefly discussed: (1) Direct effects of carbon dioxide on plants; (2) Interactions of carbon dioxide, temperature, and water stress; (3) Climate change scenarios; (4) Crop responses to climate change scenarios; (5) Agriculture adjustment options; (6) Weather and climate variability and (7) Tools needed for future predictions. 10 refs., 2 tabs.

26686 A summary of climate change impact studies on agriculture: The US Environmental Protection Agency's report to Congress on the potential effects of global climate change on the United States. Rosenzweig, C. (Columbia Univ., Palisades, NY (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper describes the structure, review process, caveats, findings and implications of the agriculture studies done for the Environmental Protection Agency report. The studies are a first step in linking predictions of climate change to models of agricultural systems. While many critical uncertainties remain about the magnitude and timing of climate change impacts, it appears that climate change will likely to affect agriculture and rural communities in the US significantly in the coming century.

26687 Likely impact of climate change on Canadian agriculture. Smit, B. (Univ. of Guelph, Ontario (Canada)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper reviews the implications of climate change for Canadian agriculture, highlights the issues of uncertainty and adaptability, and draws some conclusions for public policy. Planning for variability in climate is needed under current conditions; it becomes even more urgent under a scenario of climate change. 8 refs.

26688 How increased solar ultraviolet-B radiation may impact agricultural productivity. Teramura, A.H. (Univ. of Maryland, College Park (USA)); Sullivan, J.H. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper concentrates on the results of the only multi-year yield field study completed to date on the effects of UV-B radiation on crop yield and productivity. In 1981, two soybean cultivars used for the study were based on preliminary greenhouse trials for UV-B sensitivity and planted into the field, at the USDA Agricultural Research Center, Beltsville, Md. Based on overall growth performance, cultivar Essex was sensitive while cultivar Williams was tolerant to UV-B radiation. The interactions between UV-B radiation and potential climate changes needs further evaluation, since productivity could be profoundly influenced. 10 refs.

26689 Reducing earths greenhouse CO_2 through shifting staples production to woody plants. Rutter, P.A. (Badgersett Research Farm, Canton, MN (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Two systems of intensive food and fiber co-production using woody plants are proposed. Potential effects on atmospheric CO_2 are discussed, and could be highly significant if such systems were widely implemented. A maximum carbon fixation rate of 1.82×10^{13} g/10^6 hectares/year is calculated, more than triple the average for maize. If all the US croplands planted to maize or soybeans in 1986 (55.5 million hectares) were planted to such woody crops, at least 1.01×10^{15} carbon/year would be fixed, a large fraction of which is sequestered for long periods of time or substituted for fossil fuels. 15 refs., 2 figs.

26690 Factors affecting biological methane production. Delwiche, C.C. (Univ. of California, Davis (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Discussion covers the chemistry involved in biological methane formation. The formation of methane (swamp gas) in water-logged environments has long been recognized. Rice production, a specific agriculture practice known to produce methane, sometimes in large quantities is examined. 8 refs., 1 fig., 1 tab.

26691 Greenhouse gases released to the atmosphere from deforestation for farmland. Houghton, R.A. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The conversion of forests to agriculture lands is estimated to have released between 0.4 and 2.5 $\times$ 10^{15} g carbon, as CO_2, to the atmosphere in 1980. This release was approximately 10% to 50% of the annual emissions of CO_2 from combustion of fossil fuels. The reason for the release of carbon following deforestation is that forests hold from 20 to 100 times more carbon per unit area than agricultural lands. Current rates of changes in the area of forests are so poorly known, however, that high carbon rates cannot be ruled out. The ignorance is remarkable given the importance of deforestation to climatic change and the demonstrated ability of existing satellite data to measure the change in forest area. Expansion of the forest area would contribute significantly to stabilization of greenhouse gases in the atmosphere. 8 refs., 1 fig.

26692 The relationship of global climate change to other air quality issues. Bernabo, J.C. (Science and Policy Associates, Inc., Washington, DC (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Climate is the primary environmental variable influencing natural systems and human activities. Changes in the extremes, variability, and mean conditions of climate will affect a series of existing air quality concerns. Individual issues are linked by a complex set of relationships between emissions, atmospheric processes, and environmental consequences. Policies to address any one of these issues could influence the other problems because of the physical and societal linkages that exist among them. Discussions briefly covers the relationships and linkages. 2 refs.

26693 Linkages between climate protection and air quality strategies. Moomaw, W.R. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The atmospheric problems of global climate change induced by accelerating greenhouse effect, urban and regional air pollution, acid deposition, and stratospheric ozone depletion are interlinked both scientifically and economically. It is necessary that proposed solutions recognize this fact and be designed appropriately. Otherwise we may exacerbate one problem as we attempt to solve another and miss cost effective options, which only become apparent when an integrated policy analysis is undertaken. Some strategies for near-term and long-term policies are given.

26694 The interaction of air pollution programs and global climate change. Emison, J. (Environmental Protection Agency, Washington, DC (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The paper discusses the air quality management program in the US and its history of interacting effectively with broad societal programs and goals. The nation's investment in air pollution infrastructure can contribute much to the attack on the emerging climate issues and must be integrated fully into these programs.

26695 Likely effects of global climate change on fish associations of the Great Lakes. Regier, H.A. (Univ. of Toronto, Ontario (Canada)); Holmes, J.A.; Meisner, J.D.; Magnuson, J.J.; Hill, D.K.; Shuter, B.J. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

In the Great Lakes Basin, climate warming will likely lead to a major expansion of waters that are quite warm in summer, to the advantage of the centrarchid family (black basses, sunfish, etc.) and the percichthyid family (white bass, white perch, etc.). There will also be a major expansion of waters that attain the cool range during midsummer, especially in the northerly half of the Basin, to the advantage of the percids (walleye, yellow perch, etc.). In many parts of the Great Lakes, near shore and stream waters will become to warm in summer for the salmonids (lake trout, brook trout, Pacific salmons, lake whitefish, lake herring, etc.), but optimal temperatures will appear earlier in spring and extend later in fall. If other environmental factors are optimal, and if the fish species can freely rearrange themselves geographically and hydrographically, then climate warming should lead to an increase in overall production of preferred species. But a number of ecological mechanisms have been identified that may involve some degrading synergism between warming and other factors of the habitat. some pessimism in this respect would now be prudent. Attention should now be directed to the development of appropriate adaptive fishery strategies to climate warming of Great Lakes waters. 33 refs., 2 figs, 2 tabs.

26696 Potential impact of stratospheric ozone depletion on marine ecosystems. Worrest, R.C. (Environmental Protection Agency, Washington, DC (USA)); Gucinski, H.; Hardy, J.T. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

As a result of stratospheric ozone depletion, Ultraviolet-B radiation (UV-B) reaching marine environments is likely to increase over the next few decades. Available information suggests the UV-B radiation can have a variety of deleterious effects on marine ecosystems. The purpose of this report is to point to the current uncertainties in existing information and to speculate on the range of possible effects. It is hoped that the controversial aspects will stimulate discussion and additional needed research. 33 refs., 1 fig.

26697 A mechanism for greenhouse-induced collapse of mammalian faunas. McLean, D.M. (Virginia Polytechnic Institute and State Univ., Blacksburg (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The keys to appraising the impact of rapid greenhouse warming upon mammalian faunas are these: (1) Today, mammals are generally habituated/adapted to the climate zones they live in. (2) During a major carbon cycle-induced disorganization of the biosphere, finding new optimum thermal niches may be difficult. (3) The world we live in is a hot interglacial one, prior to the onset of any greenhouse warming. (4) Because heat is already killing embryos on a vast scale, many species may already be near to their upper thermal limits. (5) Greenhouse warming at a rate 10 to 40 times the natural would out pace the capacity of many species to reduce their surface/volume ratios sufficiently for females to maintain optimum uterine thermal environment for developing embryos. (6) In the middle latitudes, the cool months provide the prime breeding season, and the greater wintertime than summertime warming during a greenhouse would reduce breeding time in the middle latitudes. (7) Because of (6) and also polar amplification of greenhouse warming, middle-high latitude faunas face greater warming than do tropical faunas. (8) Emergence of (1) Scenario, a greenhouse warming, could trigger general collapse of mammalian faunas of the middle latitudes. 35 refs., 3 figs.

26698 Monitoring concepts useful in the assessment of climate change effects on US Fish and Wildlife Resources. Breckenridge, R.P. (EG and G Idaho, Inc., Idaho Falls (USA)); Otis, M.D. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). DOE Contract AC07-76ID01570. (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The objectives of this paper are to: (1) Discuss the sensitivity of fish and wildlife resources and their habitats to climate changes as a basis for selecting indicators of climate change effects; (2) outline and anticipatory monitoring approach for trend assessment; and (3) identify regional and national challenges for management response to effected wildlife resources. 9 refs.

26699 Climate change effects on fish, wildlife and other DOI programs. Goklany, I.M. (Dept. of the Interior, Washington, DC (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Many Department of Interior (DOI) programs and responsibilities would be significantly affected were climate to change or if measures to limit the build-up of greenhouse gases were adopted. Changes in natural resource management programs with substantial resource commitments are unlikely to change unless there are significant reductions in the uncertainties and gaps in knowledge regarding the direction, magnitude, geographical extent and timing of effects due climate change. Low cost measures are suggested for the interim. And it may be more cost effective to reduce CH_4, which has no redeeming features, than CO_2 which may help agriculture and natural systems. 9 refs., 2 figs., 3 tabs.

26700 North American forests during rapid climate change: Overview of effects and policy response options. Andrasko, K. (Environmental Protection Agency, Washington, DC (USA)); Wells, J.B. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Models of global warming from increased atmospheric CO_2 concentrations have produced forecasts of temperature and moisture changes likely to produce significant shifts in US forest ecosystems. Northward migrations of forests up to 1000 km may occur, beginning as soon as 30 years. Policy options to stabilize greenhouse gas productions are reviewed, classified as those reducing demand for forest land or products, and those increasing supply. Reforestation on surplus croplands and in urban areas in the US may provide carbon cycle benefits at low costs. Forestry response options may buy time for policy makers to alter fossil fuel consumption patterns and technologies, and to decide what to do with trees grown in the interim. 20 refs., 2 tabs.

26701 Climate change and forest fires. Fosberg, M.A. (Dept. of Agriculture Forest Service, Washington, DC (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper uses a simplified version of the US National Fire Danger Rating System to depict potential fire behavior for a number of ecosystems. The ecosystem models used to project future forests are particularly sensitive to the moisture projections of the general circulation modes. Using nine broad discrete fuel types to describe the ecosystem decreased the sensitivity of the future fire severity projections somewhat and suggested that direct weather effects may be more important in comparing future problems with current problems. 8 refs., 1 tab.

26702 Climate change and the Canadian forest. Harrington, J.B. (Petawawa National Forestry Institute, Chalk River, Ontario (Canada)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Industrial society, through the careless handling of waste products, is threatening to damage or destroy enormous areas of boreal forest. Potential damage occurs in two entirely different ways. First, sulfur and nitrogen oxides, create acid rain, which leaches minerals from plant leaves and nutrients from the soil, thereby weakening trees and increasing their susceptibility to damage by drought, insects and disease. A byproduct of these emissions, ozone, reduces photosynthesis and still further reduces the tree's vitality. Second, and of greater consequence, is the production of greenhouse gases CO_2, N_2O, CH_4, CFC's and O_3, which are predicted to warm the atmosphere to unprecedented levels. If present model predictions are correct, much of Canada's boreal forest west of the Hudson Bay will disappear to be replaced by grassland and brush. The consequences to Canada's economy would be devastating. A plea is made to intensify research on the relationship of climate to trees, fire, insects and disease. Without such basic data, intelligent resource planning will not be possible. 20 refs.

26703 Climate change and US Forest Markets. Regens, J.L. (Univ. of Georgia, Athens (USA)); Cubbage, F.W.; Hodges, D.G. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Atmospheric concentration of greenhouse gases are likely to produce global-scale climatic changes over the next 50 to 80 years affecting important societal activities. Substantial uncertainty surrounds the rate and magnitude of sub-global impacts, but existing studies suggest plausible impacts on growth patterns for managed forests. This study summarizes the results of such analysis for the dominant regions in the US, the South and Pacific Northwest, in order to identify policy responses that might ameliorate adverse implications of climate change for forestry. 9 refs., 2 tabs.

26704 Tropical forests and climate. Myers, N. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The situation with tropical deforestation is discussed and the potential benefits of a massive reforestation are examined.

26705 Mitigating climate change: Strategies to finance retention of tropical forests. Qureshi, A. (Climate Institute, Washington, DC (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Almost 25% of the annual carbon emissions to the atmosphere is due to tropical deforestation. If future global warming is to be controlled, deforestation has to be curtailed. In order to reverse the greenhouse effect, existing forests need to be restocked and already cleared areas and unculturable waste lands afforested. To provide for the increasing human population, intensification of agriculture, development of wood reserves, and sustainable land-use systems are needed. Policies of each country must be reshaped to allow for protection of climate. Research and educational institutions need to be strengthened. Both policy makers and the public must be motivated for concerted actions. Repriorization of government programs and increased funding for forestry development, climatic amelioration and environmental protection at the national, regional and international levels by the public and private sectors would be necessary to protect this planet for ourselves and the future generations. 8 figs, 1 tab.

26706 From Climate Changes and US Water Resources: A brief summary and the recommendations. Waggoner, P.E. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Climate change heightens the need to review rules about water, especially ground water, which is badly overdrawn. Transfers are already occurring as traders bring market forces to bear, even under present institutional arrangements, which are inherently

conservative to protect joint interests. This paper summarizes a detailed report on the subject and makes recommendations. 1 ref.

26707 Vulnerabilities of United States water systems to climatic change. Gleick, P.H. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Climatic changes will affect the design, construction, and operation of water-supply systems. This paper discusses critical vulnerabilities of water-supply systems to climatic variability and change, and identifies measures for evaluating these vulnerabilities in the US. 5 refs., 2 tabs.

26708 Climate change, CO_2 fertilization and evapotranspiration. Rosenberg, N.J. (Resources for the Future, Washington, DC (USA)); McKenney, M.S.; Martin, P. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The question of how climate change may alter Evapotranspiration (ET) is complex for several reasons. Greenhouse warming may alter not only temperature, but cloudiness, windiness, and humidity as well. All four factors determine the atmospheric demand for water vapors its drying power. In addition, changes in soil moisture caused by climatic change will affect the amount of water available to plant roots, and thus the amount that can be transpired. Also to be considered is the fact that one of the major greenhouse gases, carbon dioxide, can affect plant growth and resistance to the passage of water vapor into the atmosphere. Any analysis of the possible impacts of climate change on ET should examine all factors. Results of two studies and the analysis is described and reviewed for implications in the response of ET to climate change. 25 refs., 2 figs.

26709 Likely effects of climate on water quality. Jacoby, H.D. (Massachusetts Institute of Technology, Cambridge (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Changes in climate will have substantial effects on the quality of the nation's waters. Streams, rivers, and lakes are dependent on flow and temperature; estuaries are further influenced by sea level; and ground water surface. The quality of some water resources might be improved by climate change; most will not. The severity of the environmental damage will depend on how society responds. In the main, quality problems consist of bad substances put into the water by some householder, farmer, city, or industry. With shifts in climate and hydrological conditions, the mass of pollutants also will change as the country adapts. A forecast of water quality effects of climate change, therefore, is hampered by a lack of clarity about how scientific uncertainty will be resolved over time, how public understanding will grow, and how regulatory institutions will adjust. A catalog of effects and societal responses is presented. 1 ref.

26710 Beach response strategies to accelerated sea-level rise. Leatherman, S.P. (Univ. of Maryland, College Park (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper summarizes the results of a report for the Environmental Protection Agency regarding nationwide estimates for future beach fill projects. Of the approximately 7,000 miles of sandy shorelines in the US, 1,920 miles of beaches were evaluated in this study. These areas are the principal recreation beaches in the country. For comparative purposes the contrasting option of retreat is also discussed. 5 refs., 2 tabs.

26711 The threat to federal coastal protection. Goals from global warming and accelerated sea level rise. Edgerton, L.T. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The nation's three principal coastal protection goals are natural resource preservation; minimization of loss of property and life from improper coastal development; and restoring the quality of heavily polluted coastal waters. This paper focuses on coastal protection considerations in adapting to accelerated seal level rise from global warming. Policies designed to limit global warming are essential to achieving the nation's coast protection goals. Federal agencies should begin immediately the process of adapting their coastal programs to assure that they will continue to further existing coastal protection and preservation goals into the 21st century. Such revisions should be designed to further natural resource protection, minimize economic and human loss, and encourage long-term stable economic growth along our coasts.

26712 Impacts of global climate change on metropolitan infrastructure. Miller, T.R. (Urban Institute, Washington, DC (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper uses case studies of three cities to examine probable urban impacts of coming climate change on US urban infrastructure. Case studies suggest that a doubling of carbon dioxide levels primarily will require urban infrastructure investments to ensure and adequate water supply and to prevent seal level rise from inundating coastal communities. Potential major impacts are discussed. 13 refs., 2 tabs.

26713 Emergency preparedness to address climate change. Oaks, S.D. (Univ. of Colorado, Boulder (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Emergency preparedness to address climate change needs to be considered within the broader context of hazard reduction. Hazard reduction strategies for a number of different hazards, including climate related ones, have been developed. Hazard reduction measures, including emergency preparedness, can be undertaken to mitigate the effects of climate change on vulnerable communities. In determining appropriate strategies and measures, interrelated aspects of climate change and climate change induced hazards should be recognized. Some aspects are briefly discussed. 8 refs.

26714 Planning for climatic variability and uncertainty. Mugler, M.W.; Stakhiv, E.Z.; Cortner, H.J.; Rubino, M. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The role of the planner is to provide choices for the future. In the face of climate change, the water resources planner must respond to the variability of today's weather while accommodating the uncertainties of tomorrow's climate. Some tools in use today in dealing with weather variability are discussed.

26715 Factoring climate change into corporate planning: Introduction to panel discussion. Strelow, R. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Corporate planning with respect to public policy and technological steps that will be taken to limit the extent and severity of future climate change are briefly discussed. Laws, in place, being considered, and those needed are examined, along with some projected technologies.

26716 Implications of climate change for the insurance industry. Friedman, D.G. (Travelers Insurance Co., Hartford, CT (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989).

(CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

For insurance contingency planning, emergency planning and hazard mitigation activities, it is prudent to attempt to ascertain the potentially for sizeable changes in the production and severity of storm-caused natural disasters due to a greenhouse-induced warming trend in the near term and the longer term. An attempt has been made to quantify these potential near-term effects, utilizing presently available information that is consistent with the current state of knowledge about natural disasters caused by storms. The approach was to determine the catastrophe production of various storm types in the present climatic regime and then estimate changes attributable to a Greenhouse warming trend. 1 ref., 13 figs.

26717 **Regional and national effects of climate change on demands for electricity.** Linder, K.P. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Global warming in response to increased atmospheric concentrations of greenhouse gases could affect electric utilities through several different pathways. One of the most critical impact pathways is likely to be demand for electricity because of the importance of weather-sensitive demands in determining (1) the amount of generating capacity needed to meet customers' demands reliably and (2) the most efficient ways of utilizing the utility's resources. A study was conducted to estimate the potential impacts of greenhouse-gas induced temperature change on US regional and national demands for electricity, and the implications of these changes in demands for utility planning and operations. The steps in the analysis are reviewed along with implications of the findings. 2 figs.

26718 **Climate change: The implications for securities underwriting.** Medioli, A. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Global warming has broad implications for security underwriting as opposed to typical environmental issues that are usually localized in need and application. Economic dislocations are apt to accompany some aspects as substitute approaches are taken. Another implication is the potential for massive capital outlays across a sector so essential that it's effect is not localized. Coastal flooding could involve a broad range of dislocations. Combinations of local and sector wide conditions could cause large scale redevelopment of present patterns of settlement and economic activity. Strategy must be formulated to establish a disciplinary framework of actions to be undertaken.

26719 **Implications of climate change for the environmental engineering and construction industry.** Silvey, J.F. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The industrial clients served by environmental engineering and construction community are rarely able to approach and environmental problem without having some responsibility for the problem. This is true again in connection with the climatic change issue. Society is faced with very difficult choices in dealing with the climatic issue, in accepting social and economic alternatives, to reduce the consequences of our current patterns of living. A joint effort of all elements of society are necessary to make the required changes.

26720 **Potential coastal effects of climate change in the Caribbean.** Gable, F.J. (Woods Hole Oceanographic Institution, MA (USA)); Aubrey, D.G. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Changes in climate are the norm when one studies the history of the earth. The present and future climates will be influenced by two components, those that are natural and those that are man-induced. Together, these forcings will cause future climate to evolve in uncertain ways. Difficulties in estimating regional coastal effects of sea-level changes are discussed. The Caribbean region is examined and some recommendations presented. 22 refs., 1 fig.

26721 **Implications for Caribbean societies of climate change, sea-level rise and shifts in storm patterns.** Granger, O.E. (Univ. of California, Berkeley (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The impact of greenhouse warming on the Caribbean region will be evident in changes in the oceanographic and near-shore environments including coral reefs, mangrove swamp ecology, and other aquatic environments; in the atmospheric environment through changes in hurricane climatology including changes in the frequency, intensity, trajectory of storms and the destructiveness of storm surges and coastal flooding; in the spatial and temporal distribution of floods and droughts and marine transgressions into the interfluve due to sea-level rise that will destroy valuable agriculture lands on coastal plains and contaminate freshwater aquifers that are now important sources of potable water. Disasters emanating from these environmental changes will catalyze revolutionary changes in the societies of the region. 6 refs., 3 figs., 1 tab.

26722 **Implications of climatic changes in the wider Caribbean region: An overview.** Maul, G.A. (National Oceanic and Atmospheric Administration, Miami, FL (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

A summary overview emphasizes the marine coastal environment. Included are the terms of reference used for the study. Presentations cover: (1) rising temperatures and sea levels effects on ecosystems, (2) possible socio-economic changes (3) most vulnerable areas or systems and (4) models of future climates. 11 refs., 5 figs., 2 tabs.

26723 **The Arctic Sea ice record from satellites - Is there evidence of a polar warming? (And what would the likely consequences of a warming be?).** Parkinson, C.L. (NASA Goddard Space Flight Center, Greenbelt, MD (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Through satellite passive-microwave technology, it is possible to monitor global sea ice distributions on a routine basis. Satellite imagery of the Arctic region is available for most of the period since December 1972 and reveals a strong seasonal cycle with considerable inter annual variability in the sea ice cover but no consistent long term trends. The lack of evidence of an Arctic warming is counter to first-order expectations from numerical modeling of predictions that greenhouse-induced low-level atmospheric warming should be greatest in the polar regions. However, the short length of the satellite record limits the conclusions that can be drawn from it regarding long-term trends. In the event of a significant warming in the Arctic, sea ice should retreat, leading to more absorption of solar radiation at the sea surface and greater heat exchanges between ocean and atmosphere, thereby presumably intensifying the climate warming. Some consequences would be favorable, such as improved conditions for Arctic shipping operations, but the climate consequences could be very unfavorable and of uncertain magnitude. 11 refs., 1 fig.

26724 **An overview of potential effects of rapid warming of the Canadian arctic.** Lonergan, S.C. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper discusses relevant aspects of other studies and reports on economic and social impacts in the Arctic that might result

from climate warming. Topics include; physical impacts, biological system, social and economic effects. 1 ref.

26725 **Impacts of climate change on California water resources.** Knox, J.B. (Lawrence Livermore National Lab., CA (USA)); Buddemeier, R.W. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The California water system is highly engineered and managed. Although the state appears to possess abundant water resources, demand is separated from supply in both time and space. This paper addresses some of the policy, management, and research needs that will have to be met if the state's water system is to anticipate, prepare for, and operate resiliently in, a changing environment. 2 refs.

26726 **The impacts of climate change on the salinity of San Francisco Bay.** Williams, P.B. (Philip Williams and Associates, San Francisco, CA (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The San Francisco Bay is the largest estuary on the US Pacific coast. Its estuarine ecosystem is dependent on the amount and timing of freshwater inflows and the resulting salinity distribution throughout the Bay. Consequently, salinity management in the estuary is vitally important to protecting the estuarine ecosystem and the quality of water exported for agriculture and urban water users. Projected climate changes due to the greenhouse effect will greatly alter the salinity distribution in the estuary. Analysis of changes and policy implications are discussed. 5 refs., 1 fig.

26727 **Potential climate change effects on irrigated agriculture in California.** Dudek, D.J. (Environmental Defense Fund, New York, NY (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This study assesses the impacts of climate change on California's agricultural and water resource systems. A major contributor to agriculture production, it is also an important example of a highly developed irrigation system with jurisdiction cover 1,188 dams and reservoirs with gross storage capacity of 19.7 million acre-feet. The methodology used explicitly links predictions of climate change from general circulation models (GCMs) of the atmosphere with an agricultural productivity model. The climate changes assessed include temperature, evapotranspiration, precipitation, and cloudiness. The economic system exerts compensating influences which tend to modulate the ultimate influence of direct physical productivity changes. Result indicate that even after market responses function, state wide average yields would be significantly reduced for all crop groups as a result of climate changes. This case study demonstrates the importance of including all related climate change impacts within a single analytical framework. 6 refs., 2 figs.

26728 **Climate change and water resources management: Assessing capacity for institutional adaptation in the southeast.** Meo, M. (Univ. of Oklahoma, Norman (USA)); Deyle, R.E.; Malysa, L.L.; Wilson, L.A. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The Environmental Protection Agency (EPA) sponsored a study of the policy implications of potential climate change impacts on three specific regions in the southeastern US Each case study followed a hydrological emphasis and was based upon independent biophysical impact assessments using general circulation model projections of global climate altered by a doubled concentration of carbon dioxide. The overall aim of the study was to assess the institutional implications of potential impacts, weigh the vulnerabilities and strengths of individual public sector organizations and their capacity to respond to projected impacts, and develop a set of recommended actions for water management institutions. The case studies included the Tennessee Valley Authority reservoir system, the Apalachicola River estuary in Northwest Florida, and South Florida from Lake Okeechobee through the Everglades National Park. 3 refs.

26729 **Global climate change - implications for the Tennessee Valley Authority reservoir system.** Miller, B.A. (Tennessee Valley Authority, Norris (USA)); Brock, W.G. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Increased global temperatures resulting from rising concentrations of greenhouse gases are likely to be accompanied by changes in regional hydrologic cycles. The response to the Tennessee Valley Authority (TVA) reservoir system to two climate scenarios is illustrative of the significance of these changes. The wetter, warmer scenario increased water availability for power production, recreation, minimum flow requirements and water supplies, but significantly increased flood potential. The drier, warmer scenario decreased flooding, but reduced water availability for power production, recreation and water quality. Both scenarios would necessitate a reevaluation of current reservoir operating philosophy. 4 refs., 3 figs.

26730 **The impact of climate change on water quality in the southern USA: Stream water temperature.** Cooter, E.; Cooter, W. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Temperature scenarios generated by three Global Climate Models (GCMs) have been utilized to construct a range of possible temperature related water quality scenarios throughout the south and southeast. 6 refs., 4 figs., 1 tab.

26731 **Marsh loss and shore erosion with sea-level rise in Chesapeake Bay.** Kearney, M.S.; Stevenson, J.C. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper presents a brief synopsis of the magnitude and extent of marsh loss and shore erosion in the Chesapeake Bay, emphasizing how they have changed as a function of sea-level rise (and land subsidence), and ultimately look at what these processes tell us about sea level itself in the recent past. 7 refs.

26732 **Potential effects of climate change on Chesapeake Bay animals and fisheries.** Kennedy, V.S. (Horn Point Environmental Labs., Cambridge, MD (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper examines possible effects of climate warming, and the effects of changes in rainfall and sea level. Some general predictions based on known physical and biological principals are discussed and applied to striped bass, blue crab, oyster, and soft clams. 10 refs.

26733 **Preparing policymakers to address the problem of climate change.** Watson, G. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Federal, state and local governments will ultimately have to deal with the problems of climate changes. The concept of Thinking globally and Acting locally is promoted. Timely assessments and decisions are needed to establish strategies to mitigate the effects of climate instability.

26734 **The relationship between relative sea-level rise and coastal upland retreat in New England.** Giese, G.S. (Woods

Hole Oceanographic Institution, MA (USA)); Aubrey, D.G. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The report summarizes the results of recent studies of coastal upland retreat in response to relative sea-level rise. Objectives are: (1) to examine the conditions and processes that control the rate of upland retreat in response to relative sea-level rise, and (2) to quantify the rate of upland retreat under those conditions and processes. 11 refs., 2 figs.

26735 Strategies to respond to climate change and sea level rise in Atlantic Canada. Stokoe, P.K. (Dalhousie Univ., Halifax, Nova Scotia (Canada)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper focuses on five sectors of the marine economy: fisheries, marine transportation, energy development, coastal infrastructure, and tourism and recreation. Small coastal communities are especially dependent on these economic sectors, and the socio-economic and policy implications are important. Some wide-ranging measures to mitigate impacts and exploit opportunities from climate change are indicated and generalizations are drawn for overall strategies. 4 refs., 1 tab.

26736 Preparing for climate change in the Great Lakes: Introduction to panel discussion. Cohen, S.J. (Atmospheric Environment Service, Downsview, Ontario (Canada)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The Great Lakes region with its tremendous supply of fresh water, is a resource that is exploited in many ways by governments, industry, and individuals in eight states in the US and two provinces in Canada. Since 1983, more than 20 studies have been published on a wide range of topics, and more are underway. 8 refs.

26737 Summary of the US-Canada Great Lakes climate change symposium. Bolhofer, W.C. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The symposium brought together scientists, government officials, business and industry leaders, urban planners, agriculture and forestry experts, transportation and public utility managers to discuss ways to mitigate or adapt to man-induced and natural climate changes expected. The Great Lakes is a shared strategic fresh water resource, which is very vulnerable to lake level changes. Recommendations fell into four broad areas.

26738 An overview of the EPA studies of the potential impacts of climate change on the Great Lakes region. Smith, J.B. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper covers studies of changes in lake levels, ice cover, shorelines, shipping, lake thermal structure, fisheries, agriculture, forests, and to other systems. Some policy implications are discussed. 13 refs., 4 figs., 2 tabs.

26739 Climate change and the IJC [International Joint Commission]. Clamen, M. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The International Joint Commission (IJC) role and report of 1985 on Great Lakes diversions and consumptive uses is presented. Regulations being applied are discussed The impacts of global climate change could be considerable. Studies in progress should help clarify issues. 6 refs.

26740 Incentives for CFC substitutes: Lessons for other greenhouse gases. Miller, A.S. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The recent international agreement to reduce global emissions of chlorofluorocarbons (CFCs) provides a useful precedent for examination of the impact of governmental policy on the development and introduction of environmentally acceptable substitutes. The scope of the problem, industry status on substitutes and governmental efforts to reduce CFC use are discussed. 10 refs.

26741 Halon substitutions. Jewell, T.C. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

A series of slides are presented showing how halons are used, emission reduction programs, and development of alternatives. At present there are no available substitute chemicals which can be used to replace halons used for fire and explosion suppression. Progress has been made to reduce emissions and develop acceptable alternatives.

26742 Uncertainties in energy models. Edmonds, J. (Pacific Northwest Lab., Washington, DC (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The types, amounts and sources of greenhouse gases are presented. Five different classes of options to alter the rate of fossil fuel CO_2 emissions are identified and examined: (1) Precombustion carbon removal, (2) Fuel substitution, (3) Energy conservation, (4) Changing the composition of final demand, and (5) Post-combustion carbon recovery.

26743 Energy strategies to restrict emissions growth: Government strategies to limit buildup of greenhouse gases. Bardin, D.J. (Arent, Fox, Kintner, Plotkin and Kahn, Washington, DC (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This paper weighs government strategies to limit build up of greenhouse gases in the context of energy strategies to restrict emissions growth. It considers the relationship between strategies dealing with energy and non-energy gases. Government strategies may concern taxation, regulation, governmental lending and investment, guidance of government-owned and private companies, and government funding of research and development. Greenhouse gas emissions strategies could be integrated with strategies concerning such factors as clean air, flood control and shore protection, environmental diversity, employment in certain sectors, economic rationalization, development programs and geopolitical policies. Failure to integrate these strategies diminishes or cancels out their effectiveness.

26744 More efficient technologies and fuel switching: The near-term prevention strategy. Fulkerson, W. (Oak Ridge National Lab., TN (USA)); Perry, A.M.; Reister, D.B. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Worldwide CO_2 emissions continue to increase year by year. The rate of increase has been significantly lower in the 70's and 80's than it was before the oil embargo– ~ 4.6% per year during 1953-1973. Nevertheless, it is still increasing, and much of the increases comes in developing countries. To stabilize the CO_2 emissions at something like the present 5-6 GtC per year would

not be an easy task, yet it would still not prevent the CO_2 concentration from increasing. To reduce CO_2 emissions appreciably, as called for by the summary statement of the Toronto Conference, would be even more difficult and would require deep cuts in emissions by industrial nations to offset some further increase in emissions by developing nations. To reduce CO_2 emissions without inhibiting economic growth will require both very large gains in energy efficiency and massive switching from fossil to non-fossil energy sources. In the near term, only efficiency improvements, together with some shifting to natural gas, appears ready technologically to make a significant impact on reducing CO_2 emissions. Nevertheless, sustainable control of CO_2 emissions will require much better nonfossil sources. 14 refs., 8 figs.

26745 Carbon emissions trends in Canadian transportation. Jessup, P.S. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Transportation is the largest source of Canada's carbon emissions. This paper addresses three questions: (1) What are the prospects from carbon emissions from light-duty vehicles towards 2005, should petroleum prices remain stable and the federal government shy away from new fuel efficiency standards? (2) What are the prospects for achieving significant carbon emissions reductions from light-duty vehicles by 2005? and (3) What policy options should government explore to achieve reductions?

26746 Energy efficiency: A new agenda. Chandler, W.U. (American Council for an Energy-Efficient Economy, Washington, DC (USA)); Geller, H.S.; Ledbetter, M.R. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Three major priorities in the US and elsewhere-environmental quality, economic competitiveness, and energy security–provide a new and urgent rationale for saving energy. None of these ends can be fully attained without also achieving an energy-efficient economy. The US has reduced energy intensity in every major energy-consuming sector since the 1973 oil price shock, but is losing momentum in energy efficiency. Various aspects are examined and policy recommendations made. 12 refs.

26747 Status of photovoltaic solar technology. Arvizu, D.E. (Sandia National Labs., Albuquerque, NM (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). DOE Contract AC04-76DP00789. (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

A historical perspective and technology assessment is given for the present energy climate. A new opportunity for photovoltaic technology appears on the horizon. Significant progress has been made and the key question is economies of scale and industrial competitiveness. 7 refs., 4 figs.

26748 Potential energy uses and greenhouse implications of hydrogen. Hoffmann, P. (Hydrogen Letter, Hyattsville, MD (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Hydrogen is regarded as the ultimate long-term option when it comes to environmentally benign chemical fuels. Hydrogen uses and applications being studied are discussed. The main area of concern is how to produce hydrogen, economically. Potential uses in the transportation sector are examined.

26749 Ocean thermal power effect on greenhouse gases. Anderson, J.H. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

In the ocean thermal power process electrical power is generated from the thermal energy available in the ocean. An ocean thermal power plant generates power by transferring warm surface water heat thru a heat engine to a cold water heat sink deep in the ocean. The conceptual design and operating benefits are discussed. It is estimated that one shipyard could produce four power plants per week. Plans are to install four 100 megawatt power plants in the tropics, and negotiations are underway for 50 more. 10 refs., 2 figs., 1 tab.

26750 The potential for geothermal energy. Tester, J.W. (Massachusetts Institute of Technology, Cambridge (USA)); Brown, D.W.; Potter, R.M. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

This report considers several aspects of future national energy production as these aspects relate to local and world-wide energy supply and environmental degradation. Dependence on foreign oil is our critical problem. It appears that the only practical solution to this dilemma is to reduce the use of fossil fuels. The role and benefits of geothermal energy to our national energy policy are discussed. 22 refs., 7 figs.

26751 Directions in advanced reactor technology. Golay, M.W. (Massachusetts Institute of Technology, Cambridge (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The purpose of this paper is to examine the directions being pursued in nuclear reactor technology development worldwide, in the context of possible future global warming, the greenhouse effect. Current reactor development programs are categorized according to whether they are primarily concerned with enhanced economic performance or safety, although both factors must be addressed satisfactorily in any concept. 1 tab.

26752 Global energy strategies and climate change. Chandler, W.U. (Pacific Northwest Labs., Richland, WA (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Discussion covers the following topics: (1) Trends in regional carbon and methane emissions; (2) Future energy-related greenhouse gas emissions; (3) Policy experiments in emissions reductions; (3) Managing energy demand; (4) Cost-effectiveness in reducing greenhouse emissions; and (5) Policy issues. 38 refs.,

26753 Developing country energy strategies. An overview of the climate implications of energy strategies. Mintzer, I.M. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The challenge facing policy makers and managers today is to identify policy options that will limit greenhouse gas emissions without substantially slowing economic growth over the long term. The task is complicated by the significant and persistent uncertainty in regional analyses of the impacts of climate change. Substantial methodological difficulties must be overcome to develop new analytic approaches and tools. These tools will need to have long time horizons if scientists are to evaluate adequately the policies that must be implemented over 50 or 100 years. Discussion covers energy use, options, efficiency, and environmental and economic costs in developing countries. 15 refs., 1 tab.

26754 Greenhouse implications of energy policies of multilateral development institutions. Wirth, D.A. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The greenhouse problem is only one of several compelling reasons that require a swift reexamination of priorities for energy investments in Third World countries, which have expanding energy needs. There is tremendous potential for supply energy needs

through conservation and improved end-use efficiency in many developing countries. Discussion covers the role of multilateral banks. A study has started of development banks lending priorities. Preliminary recommendations are included.

26755 International progress on the Montreal Protocol. Buxton, G.V. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The Montreal Protocol puts in place an international process for controlling all ozone depleting substances. It also provides the means for increasing the stringency or tightening the time frame for such controls. Review is made of the science and stratospheric chemistry, effects of ozone depletion, substitutes and alternatives. A time line is given for the process. 2 figs.

26756 Toward an international convention for the protection of the global climate: Financial framework. Bach, W. (Univ. of Muenster (West Germany)); Scheer, H. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The presentation gives a conceptual framework of a strategy for the protection of the global climate. It's strategy is based on a business deal between the industrialized countries (ICs) and the developing countries (DCs). To defray larger costs from the impacts of the greenhouse gases - induced global climatic change, the ICs are willing to pay for an emission reduction in the DCs through a decrease in forest and soil destruction, reforestation, and the use of efficient energy technology and renewables. The financial scheme involves a uniform ¢ 0.5 /kWh CO_2-tax on fossil fuel use in OECD or EC countries amounting to $200 bill., and $50 bill., respectively. The revenues, to be put into an international fund, are earmarked for use by the DCs: i.e. 50% for debt liquidation, and the other 50% for forest and soil preservation, afforestation, agricultural reforms, improvement of the energy economy, family planning coupled with social security, etc.

26757 Effects of global warming on international Treaty obligations relating to water rights. Strock, J.M. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Given the importance of water supplies to human populations, any significant change in water availability–increases, decreases, or unpredictably wide fluctuations from historical norms–will have multifarious effects on a range of institutional arrangements. As a result, the legal and political challenges concomitant with various global warming scenarios are profound. The US treaties with Mexico and Canada involving the Colorado and Columbia rivers are reviewed as examples. 4 refs.

26758 International legal and policy options for dealing with global warming and climatic change. Ramakrishna, K. (Woods Hole Research Center, MA (USA)). pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

The first and most significant pronouncement on international legal initiatives in dealing with global warming and climate change emanated from Toronto Conference on the Changing Atmosphere: Implications for Global Security, June 1988. A fully worked out agreement, or agreement on all elements, is to be in place by 1992. The review covers other related meetings, workshops, and conferences. These activities provide a picture of the world community that can adopt appropriate measures to explore suitable avenues and deal with global problems. 12 refs.

26759 Assessing the threat to antiquities posed by climate change, sea level rise and air pollution. Sadek, H.; Topping, J.C. Jr. pp. 725 of Coping with climate change. Proceedings. Topping, J.C. Jr. (ed.). Climate Institute, Washington, DC (US) (1989). (CONF-881218–: 2. North American conference on preparing for climate change, Washington, DC (USA), 6-8 Dec 1988).

Many of the earth's prized antiquities may be in grave danger over the next generation as the result of global climate change and local air pollution. Discussion covers recent events of ancient facilities damaged or destroyed. Review is made of the Cairo conference and its role in catalyzing interest in the issue.

26760 Model estimates of enhanced photochemical production of ozone resulting from convective transport of precursors. Pickering, K.E. (Applied Research Corp., Landover, MD (USA)); Thompson, A.M.; Dickerson, R.R. vp. of Symposium on the role of clouds in atmospheric chemistry and global climate, Anaheim, CA, January 30-February 3, 1989, Preprints. . American Meteorological Society, Boston, MA (US) (1989).

Vertical profiles of net photochemical ozone production rates and total tropospheric column production rates were estimated using two models, a simple photochemical box model and a time-dependent one-dimensional transport/kinetics model. Photochemical production of ozone is found to dominate over destruction throughout the vertical extent of the troposphere over the central United States during typical summertime convective conditions. The column net production can be enhanced by the transport of the ozone precursors NO and NMHC from the boundary layer to the free troposphere by convective activity. 14 refs.

26761 The effects of enriched carbon dioxide atmospheres on plant-insect herbivore interactions. Fajer, E.D. (Harvard Univ., Cambridge, MA (USA)); Bowers, M.D.; Bazzaz, F.A. *Science (Washington, D.C.) (USA)*, 243(4895): 1198-1200 (3 Mar 1989). DOE Contract FG02-84ER60257.

Little is known about the effects of enriched CO_2 atmospheres, which may exist in the next century, on natural plant-insect herbivore interactions. Larvae of a specialist insect herbivore, Junonia coenia (Kepidoptera:Nymphalidae), were reared on one of its host plants, Plantago lanceolata (Plantaginaceae), grown in either current low (350 parts per million) or high (700 ppM) CO_2 environments. Those larvae raised on high-CO_2 foliage grew more slowly and experienced greater mortality, especially in early instars, than those raised on low-CO_2 foliage. Poor larval performance on high-CO_2 filiage was probably due to the reduced foliar water and nitrogen concentrations of those plants and not to changes in the concentration of the defensive compounds, iridoid glycosides. Adult pupal weight and female fecundity were not affected by the CO_2 environment of the host plant. These results indicate that interactions between plants and herbivorous insects will be modified under the predicted CO_2 conditions of the 21st century. 19 refs., 1 fig., 1 tab.

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Refer also to citation(s) 25311, 25316, 25322, 25323, 25324, 25327, 25328, 25329, 25330, 25331, 25332, 25333, 25334, 25335, 25337, 25339, 25340, 25341, 25342, 25444, 25539, 25557, 25563, 25589, 25590, 25602, 25791, 26009, 26032, 26514, 26528, 26538, 26581, 26582, 26605, 26613, 26654, 26782, 26790, 26794, 26795, 26796, 26797, 26799, 26803, 26804, 26805, 26822, 26823, 26824, 26825, 26826, 26827, 26828, 26829, 26833, 26834, 26892, 26893, 26902, 26904, 26908, 26911, 26925, 27008, 27009, 27146, 27147, 27148, 27149, 27150, 27151, 27152, 27153, 27174

26762 (ARL/TR–085) **Plutonium contamination in the Maralinga Tjarutja lands.** Johnston, P.N.; Lokan, K.H.; Richardson, C.K.; Williams, G.A. Australian Radiation Lab., Melbourne (Australia). Aug 1989. 31p. Order Number DE90622905. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Nuclear weapons trials conducted at Maralinga from 1960 to 1963 resulted in contamination of large areas of land with low levels of plutonium. Ground and aerial surveys and soil sampling conducted between 1984 and 1987 showed that this contamination extended beyond the boundaries of the area still controlled by the Commonwealth Government into the Maralinga Tjarutja lands. Levels of contamination beyond the boundaries of the former test range were found to be low, and were generally undetectable for all but the most sensitive measurement techniques. Soil sampling

combined with long laboratory counting was initially used to define the trace levels but the contamination was found to be particulate with a surface density of particles too low for this to be a generally useful technique. The results are presented of in-situ gamma-ray spectrometry using a portable germanium (Ge) detector to measure contamination levels of plutonium to well below 1 kBq m^{-2} in the Maralinga Tjarutja lands to the north and north-west of the Maralinga test site. 8 refs., 10 figs., 10 tabs.

26763 (CONF-8804214–2) **Modeling large-scale vegetation dynamics.** Prentice, I.C. (Uppsala Univ. (Sweden). Inst. of Ecological Botany); Monserud, R.A.; Smith, T.M.; Emanuel, W.R. Oak Ridge National Lab., TN (USA). 16 Jun 1989. 17p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC05-84OR21400. From Global vegetation change: considerations for developing a long-term research plan; Laxenburg (Austria); 16-21 Apr 1988. Order Number DE90008883. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Environmental changes affect vegetation. The dependence of plant cell processes on light, temperature, moisture, and nutrients is the basis for this, but with time the consequences of environmental changes extend to variations in community characteristics including species composition, biomass, leaf-area profiles, and the continental distributions of natural vegetation zones or biomass. In this chapter, we discuss models that are useful in analyzing responses of vegetation to large-scale environmental changes. We emphasize climate, but most concepts and approaches are pertinent to other global changes as well. First, we summarize the natural processes that dictate vegetation dynamics under changing environmental conditions. Models that relate natural vegetation distribution to climate are then described. These can be purely correlative — based on observed relationships between vegetation and climate, without regard to the mechanisms involved. But to simulate transient responses, we need dynamic models that represent community processes including competition. We summarize a class of such models that are suited to small landscape or patch analysis. We conclude by outlining a scheme for applying these models in large-scale studies, by a Monte Carlo method that samples spatial variability in the environment. 72 refs.

26764 (ENEA-RT-DISP–89-07) **Concentration limits for toxic and noxious waste landfills: Elution model.** Paris, P. ENEA, Rome (Italy). Direzione Sicurezza Nucleare e Protezione Sanitaria. Nov 1989. 23p. (In Italian). (RT/DISP–89-07). Order Number DE90764334. Available from NTIS (US Sales Only), PC A03/MF A01.

This report describes a model which may be used to derive hazardous waste concentration limits in order to prevent ground water pollution from a landfill disposal. First the leachate concentration limits are determined by taking into account the attenuation capacity of the landfill-site as a whole; waste concentrations are then derived by an elution model which assumes a constant ratio between liquid-solid concentrations. In the example, two types of landfill are considered and in each case concentration limits are calculated for some hazardous substances and compared with the corresponding regulatory limits.

26765 (EPRI-EN–6749) **Proceedings: Environmental research conference on groundwater quality and waste disposal.** Murarka, I.P. (Electric Power Research Inst., Palo Alto, CA (USA)); Cordle, S. Electric Power Research Inst., Palo Alto, CA (USA). c Mar 1990. 503p. Sponsored by Electric Power Research Institute. (CONF-8905298–: Environmental research conference on groundwater quality and waste disposal, Washington, DC (USA), 2-4 May 1989). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

An Environmental Research Conference on Groundwater Quality and Waste Disposal was held in Washington, DC on May 2–4, 1989. This conference provided a forum for discussions of the latest research on the relationships between waste disposal and groundwater quality. A total of 35 papers were presented in six different sessions dealing with waste composition and mobilization chemistry, hydrologic transport and dispersion, transport and fate models, field sampling and analysis methods, geochemical processes, and biological transformation processes. Key points brought out at the conference included the availability of data for characterizing groundwater contamination potential, the availability of several new transport and fate models, and advances in field sampling and analysis methods. Results from three major field tracer experiments indicate that quantification of dispersion parameters still is quite imprecise. This volume contains 32 papers. Individual papers are indexed separately on the data base.

26766 (ISH–135) **Radiocesium contamination of foodstuffs and the resulting radiation dose as a consequence of the accident in the nuclear power plant of Chernobyl. Contribution to the 'Nutrition report' in German and English.** Bayer, A.; Braun, H.; Dehos, R.; Frasch, G.; Haubelt, R.; Hoppe-Schoenhammer, J.; Kaul, A.; Loebke, A.; Werner, M. Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Jun 1989. 71p. (In German, English). Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

The impact of the radiation exposure via ingestion on the Federal Republic of Germany after the reactor accident in Chernobyl is demonstrated. From estimated intakes of radioactive cesium, appropriately corresponding radition doses were calculated for the years 1986 and 1987. The intake estimates are based on measurements of specific activity in food and consumed amounts of food and also on measurements of the total body activity in less (Hesse) and higher (Bavaria) contaminated regions. Effective doses from the intake of contaminated foodstuffs were about 0.04 mSv (1986, 1987) in the less contaminated region and 0.16 mSv (1986) and 0.10 mSv (1987) in the higher contaminated region. The corresponding radiation doses calculated from intake estimates of total body activity are lower by about a factor 2. The above described doses from ingestion were nearly less than 20% (Hesse) or 50% (Bavaria), respectively, in 1986, than those from the intake of natural radioactive substances (0.30 mSv). The maximum annual dose from contamination by radioactivity due to nuclear weapons tests amounted to 0.06 mSv in 1964. Accordingly, this dose was nearly 50% higher than the ingestion dose in 1986 in less contaminated regions and nearly 60% lower than the dose in higher contaminated areas. (orig.).

26767 (NRPB-R–233) **Environmental radioactivity surveillance programme: results for 1988.** Smith, D.M.; Welham, D.; Bulloch, K.A.; Carmichael, L.; Clark, I.E. National Radiological Protection Board, Chilton (UK). Dec 1989. 19p. Available from H.M. Stationery Office, London, price Pound 4.00. Available from H.M. Stationery Office, London, price Pound 4.00.

During 1987, the isotopes caesium-134 and caesium-137 were detected in air and rainwater, their presence most probably resulting from the resuspension of small amounts of the radioactive material from the Chernobyl reactor that was deposited on the ground in May 1986. The 1988 annual average activity concentrations of caesium-137 measured in air and rainwater at Glasgow were some four times lower than the 1987 values. Concentrations of caesium isotopes in milk continued to decline, the 1988 values in general being almost an order of magnitude lower than those for 1987. The UK population weighted average concentrations of caesium-134 and caesium-137 in milk resulted in an average committed effective dose equivalent to an adult of 0.7 μSv during 1988 compared with 5 μSv in 1987. (author).

26768 (ORNL/CDIAC–33) **Environmental atlas of the lowa-Kansas-Missouri-Nebraska climate-change study region.** Allison, L.J. (Oak Ridge National Lab., TN (USA)); Hunsaker, C.T.; Cushman, R.M.; White, T.W.; Draves, J.D. Oak Ridge National Lab., TN (USA). Carbon Dioxide Information Analysis Center. Mar 1990. 255p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007974. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

Environmental Sciences Division Publication No. 3461. Includes 3 overlay maps.

In 1988 the US Department of Energy (DOE) began an integrated research project to study the potential effect of changing climate on environmental resources. The area of study chosen was the four-state midwestern region of Iowa, Kansas, Missouri, and Nebraska. Baseline years are defined as 1984–1987 for agricultural crops and livestock and 1985 for water resources. Agriculture

and water — resources that are sensitive to climate, interactive, and important to the study region and to the United States — were chosen for study. Essential to an integrated regional study is a comprehensive data base of environmental resources in the region, both to characterize the regional resources as they exist today and to serve as input for modeling the response of the resources to climate change. This atlas contains 45 maps and corresponding tabulated data showing the baseline agricultural and water resource data for the Iowa-Kansas-Missouri-Nebraska study region along with basic geographic reference data. This atlas may serve as input for modeling the response of resources to climate change and provides DOE project investigators with critical baseline agricultural and water resource data for the Iowa-Kansas-Missouri-Nebraska study region. 40 refs., 8 tabs.

26769 (ORNL/RASA–88/34) **Results of the radiological survey at 14 Saint Ann Place, Rochelle Park, New Jersey (MJ032).** Foley, R.D.; Floyd, L.M. Oak Ridge National Lab., TN (USA). Mar 1990. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90009073. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. At the request of the US Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally ^{232}Th, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 14 Saint Ann Place, Rochelle Park, New Jersey (MJ032), was conducted during 1987. 4 refs., 3 tabs.

26770 (ORNL/RASA–88/36) **Results of the radiological survey at State Route 17 & Becker Avenue, Maywood, New Jersey (MJ033).** Foley, R.D.; Carrier, R.F. Oak Ridge National Lab., TN (USA). Mar 1990. 9p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90009257. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. At the request of the US Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally ^{232}Th, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. 5 refs., 2 figs., 3 tabs.

26771 (ORNL/RASA–88/91) **Results of the radiological survey at 80 State Highway 46, Lodi, New Jersey (LJ092).** Foley, R.D.; Floyd, L.M. Oak Ridge National Lab., TN (USA). Mar 1990. 15p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90009261. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. At the request of the US Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally ^{232}Th, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 80 State Highway 46, Lodi, New Jersey (LJ092), was conducted during 1988. 4 refs., 7 figs., 3 tabs.

26772 (PB–90-142878/XAB) **Durability of geosynthetics in waste-management facilities: Needed research (journal article).** Landreth, R.E. Environmental Protection Agency, Cincinnati, OH (USA). Risk Reduction Engineering Lab. c 1988. 10p. (EPA–600/D-89/152). Available from NTIS, PC A02/MF A01.

See also PB–89-132682.

The United States Environmental Protection Agency is interested in both the short- and long-term performance of geosynthetics when these materials are used in waste management facilities. The paper discusses research to address both concerns and identifies data gaps that require additional research.

26773 (PB–90-149774/XAB) **Superfund Record of Decision (EPA Region 1): Baird and McGuire, Holbrook, Massachusetts (Third remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 14 Sep 1989. 152p. (EPA/ROD/R–01-89/037). Available from NTIS, PC A08/MF A01.

See also PB–87-189981.

The Baird & McGuire site is a former chemical manufacturing facility in northwest Holbrook, Massachusetts, approximately 14 miles south of Boston. From 1912 to 1983 the company operated a chemical manufacturing and batching facility on the property. Manufactured products included herbicides, pesticides, disinfectants, soaps, floor waxes and solvents. Waste disposal methods at the site included direct discharge into the soil, nearby brook and wetlands, and a former gravel pit (now covered) in the eastern portion of the site. Underground disposal systems were also used. EPA also conducted an Initial Remedial Measure at the site from 1985 through 1987 which involved constructing a new water main to direct water away from the site, removing building structures, and installing a temporary cap. In 1986 a Record of Decision (ROD) was signed to address onsite ground water treatment and incineration of contaminated soil. This ROD addresses the Cochato River sediment contamination. The primary contaminants of concern affecting the sediment are organics including PAHs and pesticides, and metals including arsenic. The selected remedial action for the site are included.

26774 (PB–90-153743/XAB) **Superfund Record of Decision (EPA Region 3): Ordnance Works Disposal Areas, Morgantown, WV. (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 72p. (EPA/ROD/R–03-89/082). Available from NTIS, PC A04/MF A01.

Portions of this document are not fully legible.

The Ordinance Works Disposal Areas site is on the west bank of the Monangahela River in Morgantown, Monongolia County, West Virginia. Several chemical facilities have operated at the site since the early 1940s, producing substances such as hexamine, ammonia, methyl alcohol, formaldehyde, ethylene diamine and coke. The operable unit addresses onsite contamination found in the following areas: an inactive landfill where solid and chemical wastes were disposed of; a scraped area which consists of bare soil adjacent to the landfill where solid wastes were buried; two former lagoon areas which were closed following a cleanup action in 1976; and several streams located in the southern portion of the site. The selected remedial action for the site includes excavation and onsite treatment of approximately 425 cubic yards of inorganic contaminated soil from hot spots in the scraped area and lagoon area using solidification, followed by placement of the treated soil in the landfill before capping; installing a multimedia RCRA Subtitle C cap on the landfill and regarding and revegetation; excavating approximately 13,460 cubic yards of organic-contaminated soil and sediment from the lagoon area, scraped area, and streams, with onsite treatment by bioremediation in a treatment bed; ground water, surface water, and sediment monitoring; and implementing deed restrictions to prohibit residential and industrial construction at the site.

26775 (PNL-SA–17907) **Statistical sampling and analysis issues and needs for testing attainment of background-based cleanup standards at Superfund sites.** Gilbert, R.O.; Simpson, J.C. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 24p. Sponsored by Environmental Protection Agency. DOE Contract AC06-76RL01830. (CONF-9002108–1: Workshop on superfund hazardous waste, Arlington, VA (USA), 21-22 Feb 1990). Order Number DE90009171. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The primary purpose of the Workshop on Superfund Hazardous Waste is to identify statistical issues and research needs that can form the basis for a long-term statistical research and training plan

for Superfund hazardous waste site characterization and remediation. This paper discusses issues and needs that arise when statistical procedures are used to test whether remediated Superfund sites have attained site-specific background standards. Several nonparametric tests are discussed as regards their power to detect non-attainment of background standards. Some of the important issues that appear to need attention are how to select site-specific background areas, determine the types of post-remedial-action concentration distributions that are likely to occur in practice for various types of remedial actions, develop and evaluation the power of multiple-comparison slippage, quantile, and other robust tests, conduct additional power studies of the Wilcoxon, slippage, and quantile tests, for various patterns of "hot spot" contamination, develop and communicate a unified approach for deciding when to using geostatistical methods, classical testing methods as discussed here, or both simultaneously, and determine and evaluate statistical procedures that are appropriate for testing compliance with non-constant risk-based standards. 18 refs., 6 figs., 2 tabs.

26776 (PNL-SA–18039) **Ecological aspects of environmental assessment of contaminated areas.** Templeton, W.L. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-900484–1: 26. annual meeting of the National Council on Radiation Protection and Measurements, Washington, DC (USA), 4-5 Apr 1990). Order Number DE90009451. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

When large landscapes are contaminated by radionuclides released from nuclear activities, physical processes, such as atmospheric and hydrological transport may move the radioactive materials over large distances resulting in direct external exposure of man and organisms. This paper provides an overview of the modeling of radionuclide movement through defined ecological pathways, describes some ecological problems at remediated sites, and briefly reviews effects of environmental radiation on terrestrial and aquatic biota. This paper describes pathways that should be considered when conducting environmental dose assessments for radionuclides released to the environment. 4 refs.

26777 (UCRL–102045) **Nonlinear acoustic effects in rocks and soils.** Bonner, B.P.; Wanamaker, B.J. Lawrence Livermore National Lab., CA (USA). Oct 1989. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-890770–8: 16. annual review of progress in quantitative nondestructive evaluation, Brunswick, ME (USA), 23-28 Jul 1989). Order Number DE90009289. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

When natural materials are loaded by a stress field, dramatic changes in modulus occur as the microstructure deforms. The effect is primarily due to pervasive, thin microfractures which easily close under load. Nonlinear terms in the stress strain relation that governs material response can therefore be very important. Measurements of longitudinal and shear velocity under hydrostatic and uniaxial loading for various rocks are reported to illustrate these phenomena. Observations of amplitude dependent attenuation are presented to show direct evidence of nonlinear behavior. New results presented here for partially saturated rocks show the strongest nonlinear response yet reported. The formalisms of nonlinear elasticity were developed to describe the consequences of lattice anharmonicity, which implies material imperfection on the atomic scale. We will use this same formalism as a framework to quantify effects that result from the larger scale material defects which dominate the material response of rocks at low pressure. 16 refs., 4 figs.

26778 (WSRC-RP–89-816) **Reactor operation environmental information document: Volume 2, Ecology.** Wike, L.D.; Specht, W.L.; Mackey, H.E.; Paller, M.H.; Wilde, E.W.; Dicks, A.S. Westinghouse Savannah River Co., Aiken, SC (USA). Dec 1989. 1092p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009274. Available from NTIS, PC A99/MF A01 - OSTI; GPO Dep.

The Savannah River Site (SRS) is a large United States Department of Energy installation on the upper Atlantic Coastal Plain of South Carolina. The SRS contains diverse habitats, flora, and fauna. Habitats include upland terrestrial areas, varied wetlands including Carolina Bays, the Savannah River swamp system, and impoundment related and riparian wetlands, and the aquatic habitats of several stream systems, two large cooling reservoirs, and the Savannah River. These diverse habitats support a large variety of plants and animals including many commercially or recreational valuable species and several rare, threatened or endangered species. This volume describes the major habitats and their biota found on the SRS, and discuss the impacts of continued operation of the K, L, and P production reactors.

26779 A modified Freundlich adsorption equation for modeling of ion exchange reactions in soils. Polzer, W.L. (Environmental Science Group (LS-6), Los Alamos National Lab., Los Alamos, NM (US)); Essington, E.H. vp. of Proceedings of the thirtieth annual conference on bioassay, analytical and environmental chemistry. . NLO, Inc., Cincinnati, OH (USA) (1985). (CONF-8410197–: 30. annual conference on bioassay, analytical and environmental chemistry, Cincinnati, OH (USA), 10-12 Oct 1984).

In this work the authors converted the desired Langmuir equation into a modified Freundlich equation that extends the concentration of the solute to greater than trace quantities and also considers the competitive nature of ion exchange reactions. Data for the competitive adsorption of the solutes strontium, cesium and cobalt relative to calcium in a calcium-saturated Bandelier Tuff are applied to the modified Freundlich equation to demonstrate the equation's applicability. An interpretation of the numerical values of the empirical parameters for the three solutes is presented. Many mathematical relationships are used to qualify or describe the sorption of reactive solutes by soil.

26780 In situ vitrification: An innovative thermal treatment technology. Fitzpatick, V.F. (Pacific Northwest Lab., Richland, WA (USA)); Timmerman, C.L.; Buelt, J.L. pp. 591 of Proceedings of the second international conference on new frontiers for hazardous waste management. . Environmental Protection Agency (US), Cincinnati, OH (USA) (1987). DOE Contract AC06-76RL01830. (CONF-870941–: 2. international conference on new frontiers for hazardous waste management, Pittsburgh, PA (USA), 27-30 Sep 1987).

EPA/600/9-87/018F.

As management of hazardous materials gains increased attention in the United States, new and more effective technologies are being sought to immobilize and/or destroy the wastes, either in situ for previously disposed wastes or at the waste generation site. The new Hazardous and Solid Waste Amendments (HSWA) 1984 and the Superfund Amendments and Reauthorization Act (SARA) 1986, combined with proposed rule making by the U. S. Environmental Protection Agency (EPA), is making landfill disposal very costly and is moving in a direction that will severely limit future land disposal. Further, the extended liability associated with future environmental impairment provides a significant corporate incentive to dispose and delist wastes within the plant or waste site boundary. The authors discuss their development of a remedial action process for contaminated soils that is potentially significant in its application to these concerns. Although the process was initially developed to provide enhanced isolation to previously disposed radioactive wastes, recent tests have shown that many hazardous chemical wastes are also destroyed or immobilized as a result of the treatment. The process, in situ vitrification (ISV), was originally developed for the U. S. Department of Energy (DOE) and is more recently being adapted for selected commercial clients for hazardous wastes.

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Refer also to citation(s) 25317, 25318, 25319, 25326, 25341, 25348, 25440, 25441, 25444, 25445, 25556, 25563, 25565, 25573, 25575, 25576, 25578, 25641, 25642, 25643, 25644, 25645, 25649, 25650, 25905, 26020, 26579, 26605, 26613, 26654, 26765, 26773, 26774, 26776, 26778, 26892, 26893, 27154, 27155, 27156, 27157, 27158, 27159, 27160, 27164, 27168, 27169, 27170, 27171, 27174, 27175, 27183, 27186

26781 (CONF-891098–7) **Advances in groundwater modeling at Oak Ridge National Laboratory.** Bownds, J.M. (Oak Ridge

National Lab., TN (USA)); Ketelle, R.H.; Lee, R.R.; Rizk, T.A. Oak Ridge National Lab., TN (USA). [1989]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From The scientific challenge of NEPA: future directions based on 20 years of experience; Knoxville, TN (USA); 24-27 Oct 1989. Order Number DE90009400. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A groundwater flow and contaminant transport model validation study was performed to determine the applicability of verified and commonly used groundwater flow models for performance assessment of proposed waste disposal facilities at Oak Ridge, Tennessee. Standard practice site interpretation and groundwater modeling resulted in inaccurate predictions of contaminant transport at a proposed waste disposal site. The study involved iterative phases of site field investigation and modeling prior to initial modeling, the site geology and hydrogeology were intensity characterized and a groundwater dye tracer test was performed to obtain data against which model results could be compared to test accuracy. The initial site groundwater model incorporated the assumptions of horizontally layered, homogeneous but anisotropic aquifer materials. Simulations using this approach failed to accurately simulate the dye tracer behavior because of poor resolution of the heterogeneous site conditions. Subsequent modeling activities focused on generation of a model grid incorporating the observed site geologic site heterogeneity, and on establishing and using model boundary conditions based on site data. This study demonstrates that in the Oak Ridge hydrogeologic setting, conventional porous medium modeling provides only low resolution results when compared to an aquifer tracer test. Site specific geologic factors which influence groundwater flow must be incorporated in the model to achieve high resolution model results. 7 figs.

26782 (DP-MS–88-24) **Remote sensing and GIS [geographic information system] technology for wildlife habitat assessment.** Mackey, H.E. Jr. (Savannah River Lab., Aiken, SC (USA)); Ezra, C.E. Savannah River Lab., Aiken, SC (USA). [1988]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-880601–56: American Nuclear Society annual meeting, San Diego, CA (USA), 12-16 Jun 1988). Order Number DE90009300. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A geographic information system (GIS) data base was prepared for 217 square kilometers of the Savannah River Plant (SRP). Since 1952, these facilities have released once-through cooling water into several streams and lakes which eventually discharge into the Savannah River. The thermal effluents have altered wetland vegetation along the stream channel floodplains and in the SRP portion of the Savannah River swamp. Two large cooling reservoirs were constructed to reduce these effects. Terrestrial and aquatic wildlife habitat studies were conducted as part of the Final Environmental Impact Statement prepared for several cooling system alternatives. This paper addresses the use of a GIS data base and other remote sensing data in support of habitat assessments for these alternatives using the US Fish and Wildlife Service Habitat Evaluation Procedures. 9 refs.

26783 (FRCEA-TH–143) **Purification of cadmium and nickel-containing water by water hyacinth (Eichhornia crassipes) and methane production from the produced biomass.** Kaigate, B. CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Recherche Fondamentale; Chambery Univ., 73 (France). Feb 1987. 225p. (In French). Order Number DE90770655. Available from NTIS (US Sales Only), PC A10/MF A01.

The study is concerned by the removal of cadmium and nickel in synthetic sewage effluents by water hyacinth which absorb the metals, and the subsequent valorization of the biomass produced by methane production in a digester. The effects of these heavy metals on the digester performances are evaluated. The threshold toxicity of cadmium and nickel are examined and the productivity of biogas is studied as a function of the cadmium and nickel content and of the operating conditions.

26784 (GKSS–89/E/36) **Rhodamine B fluorescence measuring in Elbe river water samples.** Jahnke, J. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik). GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.); Hamburg Univ. (Germany, F.R.). Fachbereich Physik. 1989. 50p. (In German). Order Number DE90767289. Available from NTIS (US Sales Only), PC A03/MF A01.

The use of rhodamine B as a tracer in hydrography is characterized by excellent sensitivity in clear water. In turbid and polluted water, however, much poorer sensitivity must be faced. Different correction schemes developed so far, even if backed by additional measurements, introduce considerable uncertainty. In the present work a laboratory prototype of a fluorometer is presented which, using optimized values of the excitation and fluorescence wavelengths, improves the sensitivity by a factor of 100 compared to the values obtained with a commercial fluorometer in Elbe river water. (orig.) With 29 figs., 5 tabs.

26785 (KAERI/RR–718/88) **Environmental isotope-aided studies on water resources in the region of Cheju(v).** Ahn, Jong Sung (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Kim, Chun Soo; Kim, Jong Hun; Yun, Si Tae; Kim, Kae Nam; Jeong, Chan Ho. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 41p. (In Korean). Order Number DE90622935. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In order to provide effective remedial-measure for the groundwater contamination from sea water environmental isotope characteristics and groundwater composition were studied. The study area was selected in Pyoson and Namwon regions of the Cheju island, to ascertain whether the existing wells and springs are affected by sea water intrusion. The salt contents and electrical conductivity of groundwater sampled below 50 m altitude in these areas were 2≈30 times higher than those of groundwater above 50 m altitude and those of Cheju and Sogwipo cities. The groundwater in the coastal area has higher ratios (3.00≈97.2) of chloride /bicarbonate than those in the inland area, and it was classified as a Na-Cl type water. It is concluded that the groundwater in the coastal area is already contaminated. But it can be used for agricultural purpose because the SAR ratio is relatively low. (Author).

26786 (KFK-PEF–50-Vol.2, pp. 603-613) **Analytics of cloud- and fogwater constituents: Existing and yet to be provided methods.** Metzig, G. (Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Lab. fuer Aerosolphysik und Filtertechnik 1); Lammel, G. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

The aim of the project is the quantification of the acid input into fogs through particles and through acidifying reactions within droplets. Cloud- and fogwater is sampled regarding different types of fog. Field campaign are performed at various sites in the Rhine valley, and in the Black Forest mountain and Vosges mountain. With increasing humidity atmospheric aerosol particles undergo water uptake and thus may grow to fog or cloud droplets. The solutes thereof will reflect the chemical composition of the initial particle. The concentration of dissolved species have been found to be further related to the liquid water content of air and to the droplet size spectrum. The partitioning of water-soluble gases will be altered by changing liquid water content and changing chemical composition of the liquid phase. In order to understand about the processes governing the acidification of fog- and cloudwater the acids, gas- and liquid-phase precursors, as well as potential reactants are determined quantitatively within a reasonable time resolution with respect to the time scale of the fog event. (orig.).

26787 (OME/APIOS–90-01113) **Lake neutralization experiments in Ontario 1981-1987: Summary of phase 1.** Dodge, D.P.; Booth, G.M.; Richman, L.A.; Keller, W.; Tomassini, F.D. Ontario Ministry of Natural Resources, Toronto, ON (Canada); Ontario Ministry of the Environment, Toronto, ON (Canada). Acid Precipitation in Ontario Study. Sep 1988. 41p. (MICROLOG–90-01113). Available from PC Acid Precipitation in Ontario Study Coordination

Office, Ministry of the Environment, 40 St. Clair Avenue West, 7th Floor, Toronto, ON, CAN M4V 1M2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

A 5-year program was initiated in Ontario to examine the feasibility of using neutralization to protect lakes in danger of acidification, to rehabilitate lakes already acidified, and to neutralize specific sites within lakes. Results are reported for the first phase of this program. The two lakes selected for this phase were neutralized by powdered limestone dropped from a water bomber, and liming of lake shoals known to be spawning areas for lake trout was done with a mixture of different sizes of calcite. In the acidic Bowland Lake, whole-lake neutralization successfully imroved water quality for biota and provided a suitable environment for lake trout spawning and successful hatching of eggs. The lake pH increased from 4.9 to 6.7, alkalinity increased from <0.3 mg/l to 4.5 mg/l, and total Al decreased gradually from 130 to 30 μg/l. Other organisms in the lake showed changes in species abundance and biomass, but did not appear to be negatively affected. Over a 2.5-y period after liming, the whole-lake pH, Ca, and alkalinity of the lake decreased; about 40% of the added alkalinity was lost. In low-alkalinity Trout Lake, neutralization successfully raised pH and alkalinity. Short-term experiments showed that whole-lake neutralization provides additional protection against acidification, without adversely affecting the ecological community of the lake, including a lake trout fishery. After neutralization, about 25% of the added alkalinity was lost within 18 months. The spawning shoal tests were inconclusive due to small sample sizes and relatively low rates of mortality. 4 refs., 14 figs., 1 tab.

26788 (ORNL/FTR–3555) **[Modeling the upper ocean and its interaction with the atmosphere]: Foreign trip report, March 10–14, 1990.** Peng, Tsung-Hung. Oak Ridge National Lab., TN (USA). 28 Mar 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008980. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the International Meeting on Modeling the Physics, Biology and Chemistry of the Upper Ocean and Its Interaction with the Atmosphere in London, England, and presented a lecture entitled "Modeling the Seasonality of CO_2 in the North Atlantic." This international meeting was jointly sponsored by the International Geosphere Biosphere Programme and the Joint Global Ocean Flux Study. Most lectures focused on the modeling of the upper ocean, with a particular emphasis in the area of marine biology and marine ecosystems. Models ranged from simple box ocean models to general circulation models. A total of 16 papers were presented in this two-day conference. At the end of the conference, it became clear that a better understanding of global change in climate atmospheric CO_2 variations requires a closer link between the studies of marine biology and ocean physics and chemistry.

26789 (ORNL/FTR–3559) **[Hydrogeology of hazardous waste, Sede Boker Campus, Ben-Gurion University, Israel]: Foreign trip report, March 16, 1990–March 24, 1990.** Stow, S.H. Oak Ridge National Lab., TN (USA). 29 Mar 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009296. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This trip report describes progress made by the International Commission on the Hydrogeology of Hazardous Waste in preparing a document on hydrogeologic and environmental issues associated with siting of hazardous waste disposal facilities. This document follows the successful completion of a commission report on siting of facilities for subsurface disposal of liquid wastes. Also contained in this trip report are descriptions of water and waste management activities throughout the southern part of Israel. Water availability and the need to protect the country's limited water supplies from contamination resulting from waste disposal are issues of paramount importance to Israel.

26790 (ORNL/M–1041) **Polychlorinated biphenyls of the aquatic environment of Oak Ridge National Laboratory report of 1989.** Taylor, F.G. Jr. Oak Ridge National Lab., TN (USA). Apr 1990. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010216. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A Polychlorinated Biphenyl (PCB) monitoring plan was developed in compliance with the Clean Water Act and Oak Ridge National Laboratory's National Pollutant Discharge Elimination System (NPDES) permit to identify sources of PCBs, their potential movement in drainage systems, and the potential for reaching area-receiving waters. PCBs are known to be persistent in the environment, relatively insoluble in water, bioaccumulate in aquatic organisms, and are hazardous to humans through ingestion pathways of PCB-contaminated foods and through direct exposure. The primary sources of PCBs from ORNL are dielectric oils in electrical transformers. 3 refs., 2 figs., 5 tabs.

26791 (PB–89-910213/XAB) **Selected Water Resources Abstracts. Annual Cumulated Indexes to Volume 22, 1989. Part 1. Author, Organization, Accession Number. Part 2. Subject. Monthly report.** Geological Survey, Reston, VA (USA). Water Resources Scientific Information Center. 1989. 2167p. Available from NTISPC $65.00.

Paper copy also available on subscription, North American Continent price $155.00/year; all others write for quote.

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the Water Resources Thesaurus. The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

26792 (PB–90-126459/XAB) **Preliminary data summary for the hospitals point-source category.** Strassler, E.; Hund, F.H. Environmental Protection Agency, Washington, DC (USA). Office of Water Regulations and Standards. Sep 1989. 79p. (EPA–440/1-89/060-N). Available from NTIS, PC A05/MF A01.

The summaries were prepared in order to allow EPA to respond to the mandate of Section 304(m) of the Clean Water Act. Summaries for categories already subject to rulemaking were developed for comparison purposes, and contain only the minimum amount of data needed to provide some perspective on the relative magnitude of the pollution problems created across the categories. The document summarizes the most current information available regarding the discharge of wastewater and solid wastes containing priority and hazardous non-priority pollutants by hospitals. The document provides a technical basis for determining whether additional national regulations should be developed pursuant to the Clean Water Act (CWA), and makes available preliminary information regarding the discharge of priority and hazardous non-priority pollutants by the hospital industry.

26793 (PB–90-130956/XAB) **Historical perspectives of water quality in Saginaw Bay.** Richardson, W.L.; Kreis, R.G. Environmental Protection Agency, Grosse Ile, MI (USA). Large Lakes Research Station. 1990. 46p. (EPA–600/D-89/191). Available from NTIS, PC A03/MF A01.

The paper reviews past and present water quality conditions in Saginaw Bay, MI. Data and ideas in published and unpublished reports from 1937 to the present are summarized from old reports written years ago by the U.S. Public Health Service, Federal Water Pollution Control Administration, Federal Water Quality Agency, the Environmental Protection Agency, and others.

26794 (PB–90-136185/XAB) **Health assessment for Rose Disposal Pit, Lanesborough, Berkshire County, Massachusetts, Region 1. CERCLIS No. MAD980524169. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 28 Jul 1989. 28p. Available from NTIS, PC A03/MF A01.

Rose's Disposal Pit is located in Lanesborough, Berkshire County, Massachusetts. For eight years, this pit served as a dumping site for waste oils and solvents generated at the GE facility in

Pittsfield, MA. A groundwater contamination plume containing vinyl chloride, a known human carcinogen, extends from the pit eastward into a state park and southward into a pond where these contaminants are carried off-site by surface water. The disposal pit contains free waste oil consisting of large amounts of polychlorinated biphenyls (PCBs) and volatile organic compounds (VOCs). The PCBs have migrated from the pit and are imbedded in pond sediment on the Rose property. Elevated levels of PCBs have also been detected in surface soil on the periphery of the pit near a state park. The groundwater, surface water and pond sediment all constitute environmental pathways for off-site migration of these hazardous substances. Heavy water flow will continue to push these contaminants off-site. The contaminants are migrating to areas where there is a potential of human exposure.

26795 (PB–90-137977/XAB) **Health assessment for Shpack Landfill, Attleboro/North, Massachusetts, Region 1. CERCLIS No. MAD980503973. Preliminary report.** Massachusetts Dept. of Public Health, Boston, MA (USA). 18 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

Sponsored by Agency for Toxic Substances and Disease Registry, Atlanta, GA.

The Shpack Landfill site is on the National Priorities List (NPL). The landfill received both domestic and industrial waste, including inorganic and organic chemicals as well as radioactive waste. Ground water contains vinyl chloride, trichloroethylene, trans-1,2-dichloroethylene, tetrachloroethylene, chromium, barium, copper, nickel, manganese, arsenic, cadmium, lead, polychlorinated biphenyl-1260 (Aroclor-1260), radium-226, alpha particles and beta particles. Surface and subsurface soil samples contained radium-226, uranium-238, uranium-235, uranium-234, and visual evidence of metal plating waste sludges. The site is considered to be of potential health concern because of the risk to human health caused by the potential for exposure to hazardous substances via ingestion of contaminated soils at the site and future ingestion of contaminated domestic well water.

26796 (PB–90-138371/XAB) **Superfund Record of Decision (EPA Region 10): Northwest Transformer, Whatcom County, Washington (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 15 Sep 1989. 76p. (EPA/ROD/R–10-89/018). Available from NTIS, PC A05/MF A01.

Portions of this document are not fully legible.

The Northwest Transformer site (NWT), a 1.6-acre former salvage yard, is approximately 2 miles south of Everson in Whatcom County, Washington. The site is in a rural area and is bordered by low-density residential areas to the north and east, and farmland to the south. The NWT site was used for transformer storage and salvage. Storage and salvage operations were conducted in an onsite barn where PCB-contaminated dielectric fluid was drained from the transformers before dismantling. Transformer casings and associated parts were incinerated onsite, and some of the recovered oil was burned to heat the barn. Spillage and leakage of PCB-laden oil on the ground appeared to have occurred frequently, and some oil apparently was dumped directly into a seepage pit onsite, contaminating soil and possibly ground water. This operable unit includes investigations of ground water and the onsite barn to determine whether either is sufficiently contaminated to merit a subsequent operable unit. The primary contaminant of concern affecting the soil is PCB. The selected remedial action for this are site included.

26797 (PB–90-141938/XAB) **Health assessment for Geiger (C and M Oil) Site, Charleston County, South Carolina, Region 4. CERCLIS No. SCD980711279. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Mar 1987. 13p. Available from NTIS, PC A03/MF A01.

The Agency for Toxic Substances and Disease Registry (ATSDR) was requested to review and comment on the revised Remedial Investigation (RI), Revised Risk Assessment, and draft feasibility study of the Geiger Site, Charleston County, South Carolina. The RI demonstrated that there was chromium, lead, PCB, and PAH contamination in soil, groundwater, surface water, and sediment. However, the data indicated that the contamination generally was confined to on-site. The risk assessment indicated that under a future use scenario of residential development, there was significant public health risk from exposure to lead, PCB, and benzene. Seven remedial alternatives addressed soil contamination and four addressed groundwater contamination. Any remedial action decided upon should have both soil and groundwater components. Any combination of alternatives for soil and groundwater beyond no action with monitoring will adequately protect public health.

26798 (PB–90-142597/XAB) **Green Bay/Fox River mass balance study. Executive summary. Report for 1988-90.** Science Applications International Corp., McLean, VA (USA). Aug 1989. 24p. Available from NTIS, PC A03/MF A01.

Mass balancing of all direct and indirect multiple sources, pathways, and sinks of toxic contaminants can provide a knowledge base for adequate control and management of the Great Lakes Basin. The Green Bay/Fox River Mass Balance Study is a major coordination of environmental research activities among some eleven State and Federal agencies to measure major loads and the fate and movements of PCBs, dieldrin, cadmium, and lead in and out of the Green Bay/Fox River ecosystem. In the period between August 1988 and September 1989, measurements of bottom sediments, Bay-Lake exchange, atmospheric deposition, tributary loads, biota, etc., will be made; analysis will be carried out through June 1990, with the final report scheduled of September 1991.

26799 (PB–90-142746/XAB) **Yukon Delta: A synthesis of information.** Thorsteinson, L.K.; Becker, P.R.; Hale, D.A. National Ocean Service, Anchorage, AK (USA). Ocean Assessments Div. 1989. 102p. Available from NTIS, PC A06/MF A01.

The report provides a synthesis of environmental information on the Yukon Delta, primarily using results from studies conducted since 1983. The synthesis characterizes the major physical properties and resources of the Yukon Delta and identifies regional trends in biological use of major habitats. The Yukon Delta provides important seasonal habitat for numerous species of migratory birds, fish, and some marine mammals. The delta is characterized as a pass-through system or exporting-type estuary, where physical processes (river flooding, ice transport, coastal currents, and tidal mixing) and biological processes (metabolism and migration) annually remove wetland energy reserves (plants, invertebrates, and fish).

26800 (PB–90-142852/XAB) **Distribution and characterization of PCBs (polychlorinated biphenyls) in Lake Michigan water.** Swackhamer, D.L.; Armstrong, D.E. Wisconsin Univ., Madison, WI (USA). c 1987. 15p. Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Great Lakes Research 13, No. 1, 24-36(1987).

Polychlorinated biphenyls (PCBs) were measured in the water column of Lake Michigan at 28 stations. Distributions between dissolved and particulate phases were used to evaluate the partitioning behavior of PCBs. The average PCB concentration in Lake Michigan was 1.8 ng/l, corresponding to a total PCB burden of 8,900 kg. The average PCB concentration was significantly lower in open lake (1.2 ng/l) than in nearshore zone samples (3.2 ng/l). Concentrations in Green Bay were elevated compared to the rest of the lake. Variations in concentration with depth were small. The average log of the water-particle partition coefficient (Kp) was 5.9. Little dependence of Kp on particulate organic carbon was observed. A relationship was found between log Kp and log SPM (suspended particulate matter) concentration, perhaps reflecting association of a non-filterable fraction of the SPM with the aqueous phase.

26801 (PB–90-142944/XAB) **Lake resources at risk to acidic deposition in the Upper Midwest.** Schnoor, J.L.; Nikolaidis, N.P.; Glass, G.E. Environmental Protection Agency, Duluth, MN (USA). Environmental Research Lab. c 1986. 12p. (EPA–600/J-86/521). Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of the Water Pollution Control Federation, Vol. 58, No. 2, 139-148(1986).

The acidification of lakes and streams as a result of acid precipitation has been documented in southern Sweden and Norway, the northeastern United States, and southern Ontario. Simple and complex models have been used to assess the impact of acidic deposition on lakes and streams. One model development (the Trickle-down model) places particular emphasis on the kinetics of chemical weathering in the watershed as the primary mechanism

that produces cations (Ca(+2), Mg(+2), K(+), Na(+)) and neutralizes acid inputs. In the study the Trickle-down model was used to simulate lake response and to predict the percentage of lakes in the Upper Midwest of the United States at risk at various levels of acidic deposition.

26802 (PB–90-143496/XAB) **Water quality criteria and advisories, sediment criteria, and complex mixtures limits: Chronological development.** Jaworski, N.A. Environmental Protection Agency, Narragansett, RI (USA). Environmental Research Lab. Dec 1989. 15p. (EPA–600/8-89/081). Available from NTIS, PC A03/MF A01.

The development and implementation of Water Quality Criteria and Advisories, Sediment Quality Criteria, and Whole Effluent/ Complex Mixtures Limits have evolved scientifically since the early 1900's. The technology transfer document is an attempt to capture this rich and scientifically rewarding history. In developing this chronology, the authors attempt to provide the reader not only a chronology of events, but also the resulting regulatory actions that followed the scientific developments. Finally, they have added an appendix which includes additional support materials for waste load allocation, monitoring, and other support documents.

26803 (PB–90-143678/XAB) **Health assessment for Newcastle Abandoned Container Site, Newcastle, Delaware, Region 3. CERCLIS No. DED058980442. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Nov 1988. 7p. Available from NTIS, PC A02/MF A01.

The Newcastle Abandoned Container site is listed on the National Priorities List. On February 28, 1986, radioactive, corrosive, and toxic materials, and a large number of containers filled with unknown material, were inventoried, containerized, and removed. On-site contamination consists of polychlorinated biphenyls, trichloroethylene, creosote, chloroform, and di-n-butylphthalate in soil; and tetrachloroethylene, acetone, xylene, trichlorofluoromethane, trichloroethylene, and tris(betachloroisopropyl)phosphate in groundwater. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via groundwater. The potential for contamination of the lower aquifer should be investigated.

26804 (PB–90-143850/XAB) **Health assessment for Kane and Lombard Street Drums Site, Baltimore, Maryland, Region 3. CERCLIS No. MDD980923783. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 26 Jul 1988. 13p. Available from NTIS, PC A03/MF A01.

The Kane and Lombard Street Drums site is located on the east side of Baltimore, Maryland, in an industrial-zoned area. On-site soil and groundwater are contaminated with polychlorinated biphenyls (PCSs), volatile organic compounds (VOCs), and cadmium, but do not appear to be a public health concern. Direct contact with on-site soils does not appear likely because of partial cap of the contaminated area and restricted access to the site. On-site groundwater is not used for potable purposes.

26805 (PB–90-143991/XAB) **Health assessment for Stanley Kessler, King of Prussia, Montgomery County, Pennsylvania, Region 3. CERCLIS No. PAD014269971. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 5 Dec 1988. 8p. Available from NTIS, PC A02/MF A01.

The Stanley Kessler site in King of Prussia, Pennsylvania, is a former metal recycling facility which operated from 1961 until 1978. Organic solvent-contaminated cooling water was disposed of in an underground septic tank and cesspool which has no structural bottom. Located nearby is a major source of drinking water for the Philadelphia Suburban Water Company which serves approximately 800,000 people. The environmental contamination consists of trichloroethylene, 1,1-dichloroethylene, and 1,1,1-trichloroethane in groundwater; 1,1,1-trichloroethane, 1,1-dichloroethylene, ethyl benzene, methylene chloride, tetrachloroethylene, toluene, and trichloroethylene in soil. The site appears to have been remediated with the exception of groundwater contamination. However, no data concerning the effectiveness of the removal operations conducted in 1981 were provided. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via groundwater. This judgment is based on the absence of information concerning off-site contamination in soil and surface water, and the location, depth, and use of local private wells.

26806 (PB–90-145715/XAB) **Fiscal Year 1988 program report: Rhode Island Water Resources Center.** Poon, C.P.C. Rhode Island Univ., Kingston, RI (USA). Water Resources Center. Jul 1989. 61p. Available from NTIS, PC A04/MF A01.

See also report for Fiscal Year 1986, PB–88-104690.

The State of Rhode Island is active in water resources planning, development, and management activities which include legislation, upgrading of wastewater treatment facilities, upgrading and implementing pretreatment programs, protecting watersheds and aquifers throughout the state. Current and anticipated state water problems are contamination and clean up of aquifers to protect the valuable groundwater resources; protection of watersheds by controlling non-point source pollution; development of pretreatment technologies; and deterioring groundwater quality from landfill leachate or drainage from septic tank leaching field. Seven projects were included covering the following subjects: (1) Radon and its nuclei parents in bedrocks; (2) Model for natural flushing of aquifer; (3) Microbial treatment of heavy metals; (4) Vegetative uptake of nitrate; (5) Microbial process in vegetative buffer strips; (6) Leachate characterization in landfills; and (7) Electrochemical treatment of heavy metals and cyanide.

26807 (PB–90-146275/XAB) **Eastern Lake Survey: Phase 2 and National Stream Survey. Phase 1. Processing laboratory operations report.** Arent, L.J.; Morison, M.O.; Soong, C.S. Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV (USA). Aug 1989. 70p. Available from NTIS, PC A04/MF A01.

The National Surface Water Survey was designed to characterize surface water chemistry in regions of the United States believed to be potentially sensitive to acidic deposition. The National Stream Survey was a synoptic survey designed to quantify the chemistry of streams in the areas of the United States known to contain low alkalinity waters. Phase II of the Eastern Lake Survey was designed to address temporal variability of chemical and biological characteristics of a subset of Phase I lakes. The document describes the centralized processing laboratory operations associated with the 1986 surveys. The processing laboratory is located in Las Vegas, Nevada.

26808 (PB–90-147687/XAB) **Horizontal and vertical distribution of PCBs (polychlorinated biphenyls) in southern Lake Michigan sediments and the effect of Waukegan Harbor as a point source.** Swackhamer, D.L.; Armstrong, D.E. Wisconsin Univ., Madison, WI (USA). c 1988. 15p. Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Great Lakes Research, Vol. 14, No. 3, 277-290(1988).

The spatial distribution of PCBs in southern Lake Michigan sediments was obtained from the analysis of 66 box cores and 8 grab samples. PCB concentrations in surficial sediments were closely related to the sedimentation zone and to the oxidizable organic matter content of the sediments. Average surficial sediment concentrations ranged from 81 micrograms/g in depositional zones to 7.2 micrograms/g in non-depositional zones. The vertical distribution of PCBs was determined at several sites and was used to estimate the areal burden and flux of PCBs in each of the southern sedimentation zones. The total sediment PCB burden in the southern portion of the lake was estimated to be 5,900 kg. Southern Lake Michigan has received PCBs since approximately 1930 at an average flux of 7.1 micrograms/sq m/yr. The effect of Waukegan Harbor as a point source of PCBs to Lake Michigan was evaluated by comparing the PCB distribution and Aroclor composition of harbor sediments to those of sediments of decreasing distances from the harbor. Significant differences in total PCB concentration between non-depositional zones near the harbor and those in other areas of the basin indicate that Waukegan Harbor has influenced the PCB burden of Lake Michigan.

26809 (PB–90-147935/XAB) **Chesapeake Bay Basin Monitoring Program Atlas. Volume 1. Water quality and other physiochemical monitoring programs.** Heasly, P.; Pultz, S.;

Batiuk, R. Environmental Protection Agency, Annapolis, MD (USA). Chesapeake Bay Program. Aug 1989. 434p. (CBP/TRS–34/89). Available from NTIS, PC A19/MF A03.

See also Volume 2, PB–90-147943.

The Monitoring Program Atlas provides an overview of current long-term environmental monitoring programs in the Chesapeake Bay Basin. The Atlas covers a wide scope of program types, ranging from water quality, living resources, toxics, and physical processes to air quality, acid deposition and climate monitoring programs. The two-volume publication is intended to facilitate coordination and integration of environmental monitoring programs and to encourage the collection of comparable monitoring data basinwide.

26810 (PB–90-147943/XAB) **Chesapeake Bay Basin Monitoring Program Atlas. Volume 2. Biological and living resource monitoring programs.** Heasly, P.; Pultz, S.; Batiuk, R. Environmental Protection Agency, Annapolis, MD (USA). Chesapeake Bay Program. Aug 1989. 334p. (CBP/TRS–35/89). Available from NTIS, PC A15/MF A02.

See also Volume 1, PB–90-147935.

The Monitoring Program Atlas provides an overview of current long-term environmental monitoring programs in the Chesapeake Bay Basin. The Atlas covers a wide scope of program types, ranging from water quality, living resources, toxics, and physical processes to air quality, acid deposition and climate monitoring programs. The two-volume publication is intended to facilitate coordination and integration of environmental monitoring programs and to encourage the collection of comparable monitoring data basinwide.

26811 (PB–90-149006/XAB) **Hydrographic data from the Texas Continental Shelf and Northwest Continental Slope of the Gulf of Mexico: TAMU (Texas A and M University) ecosystem research group Rings Cruise 88g-05. Technical report.** Minerals Management Service, Metairie, LA (USA). Gulf of Mexico OCS Regional Office. 22 Nov 1988. 217p. (MMS/GM–88/05-T). Available from NTIS, PC A10/MF A02.

Portions of this document are not fully legible.

The cruise continued and extended the cooperation between Texas A and M University and Mexico's naval oceanographic division begun in the fall of 1987 on GYRE cruises 87G-11 and 87G-12. As in the fall of 1987, the cruise track covered the upper continental slope as well as the continental shelf of the northwest Gulf of Mexico with a grid of closely-spaced CTD and XBT stations. Projects included the following: (1) a survey of the T/S and nutrients + oxygen + chlorophyll signature of a mesoscale warm-core ring in the northwest Gulf; (2) collections with drifting sediment traps near the center of the warm ring; (3) standard stations in water depths of 20 m, 50 m, 100 m, and 200 m off Galveston and Corpus Christi; (4) collections with a 30-ft otter trawl at 200 m, 300 m, and 400 m along the upper continental slope just seaward of the shelf transects off Galveston and Corpus Christi; (5) daily measurements of 14C production to compare primary productivity of shelf with slope regions of the northwest Gulf.

26812 (PB–90-149055/XAB) **Fiscal Year 1988 Program Report: Wisconsin Water Resources Center.** Chesters, G. Wisconsin Univ., Madison, WI (USA). Water Resources Center. Aug 1988. 34p. Available from NTIS, PC A03/MF A01.

See also report for Fiscal Year 1987, PB–89-128441.

The FY 1988 Wisconsin Water Resources Center's program consisted of the Director's office program, three research projects and an information dissemination/technology transfer program. As in recent years the program has focused on groundwater quality research, which has been deemed a priority item nationally, regionally, and at state and local levels. Also addressed is the issue of the impacts of surface water pollution abatement programs on groundwater quality. With the new emphasis on nonpoint pollution in the Clean Water Act, evaluating the roles of federal, state and local governments in implementing abatement programs is a national priority. The Water Resources Center continued to provide training and practical experience for undergraduate and graduate students.

26813 (PB–90-149840/XAB) **Superfund ground-water issue: Accuracy of depth to water measurements. 2nd in series of issue papers.** Thornhill, J.T. Environmental Protection Agency, Ada, OK (USA). Robert S. Kerr Environmental Research Lab. Aug 1989. 5p. (EPA–540/4-89/002). Available from NTIS, PC A01/MF A01.

The accuracy of depth to water measurements is an issue identified by the Regional Superfund Ground Water forum as a concern of Superfund decision-makers as they attempt to determine direction of ground-water flow, areas of recharge or discharge, the hydraulic characteristics of aquifers, or the effects of manmade stresses on the ground-water system. The wetted graduated steel tape, electrical and air line methods are discussed along with frequency of measurements. The graduated steel tape method is considered to be the most accurate for measuring the water level in nonflowing wells.

26814 (PB–90-150806/XAB) **Proximity of Louisiana sanitary landfills to wetlands and deepwater habitats. Data on individual landfills.** Lambou, V.W.; Herndon, R.C.; Moerlins, J.E.; Gebhard, R.L. Florida State Univ., Tallahassee, FL (USA). Center for Biomedical and Toxicological Research and Hazardous Waste Management. Dec 1989. 30p. Available from NTIS, PC A03/MF A01.

See also PB–90-150814.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. This report documents the proximity of sanitary landfills included in the study in Louisiana to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.). The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. The nearness or proximity of the sanitary landfills to wetlands and deepwater habitats was determined by drawing three concentric regions around the point representing the location of each landfill. The radii of the concentric regions were: 1/4 mile, 1/2 mile, and 1 mile. A companion report summarizes the statewide results. The data on individual landfills include general facility/site data and wetlands/deepwater habitat data. These facilities have the potential to adversely affect sensitive ecosystems, such as wetlands and deepwater habitats, either through habitat alterations or through the migration of contaminants from sanitary landfills.

26815 (PB–90-150814/XAB) **Proximity of Louisiana sanitary landfills to wetlands and deepwater habitats. Statewide results.** Lambou, V.W.; Herndon, R.C.; Moerlins, J.E.; Gebhard, R.L. Florida State Univ., Tallahassee, FL (USA). Center for Biomedical and Toxicological Research and Hazardous Waste Management. Dec 1989. 33p. Available from NTIS, PC A03/MF A01.

See also PB–90-150806.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. This report summarizes the proximity of sanitary landfills in the state of Louisiana to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.). The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. The nearness or proximity of the sanitary landfills to wetlands and deepwater habitats was determined by drawing three concentric regions around the point representing the location of each landfill. The radii of the concentric regions were: 1/4 mile, 1/2 mile, and 1 mile. Most sanitary landfills in the state of Louisiana are located in or are close to either wetlands or deepwater habitats. Most are located close to wetlands while more than half are close to deepwater habitats. These facilities have the potential to adversely affect sensitive ecosystems, such as wetlands and deepwater habitats, either through habitat alterations or through the migration of contaminants from sanitary landfills.

26816 (PB–90-150822/XAB) **Framework for real-time decision making: New Bedford Harbor pilot dredging study.** Nelson, W.G. Environmental Protection Agency, Narragansett, RI (USA). Environmental Research Lab. Nov 1989. 14p. (EPA–600/8-89/084). Available from NTIS, PC A03/MF A01.

New Bedford Harbor is located along Buzzards Bay between the cities of New Bedford and Fairhaven, Mass. Since the 1940s, electronics and manufacturing companies in the area have discharged effluents containing polychlorinated biphenyls (PCBs) into the Acushnet River and the harbor. Over the past 15 years, nearly

18,000 acres of PCB- and heavy metals-contaminated sediment have been identified, with PCB concentrations as high as 100,000 parts per million (ppm) in some areas of the upper harbor. In 1982, the site was added to the Environmental Protection Agency's (EPA) National Priorities List of hazardous waste sites slated for cleanup under the Superfund Act. A feasibility study conducted by EPA in 1984 proposed several alternatives for the remediation of NBH including dredging contaminated sediments out of the harbor. Federal, State, and local officials, as well as the public, expressed concern over dredging. Many believed that sediments resuspended during dredging would cause the release of contaminants that would affect biota inhabiting both the harbor and Buzzards Bay. Others cited potential pollution problems from contaminated water (leachate) leaking from the proposed disposal site. In order to address these concerns, the EPA decided to pre-test dredging and possible disposal options.

26817 (PB–90-150848/XAB) **Proximity of Georgia sanitary landfills to wetlands and deepwater habitats. Statewide results.** Moerlins, J.E.; Herndon, R.C.; Lambou, V.W.; Gebhard, R.L. Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring Systems Lab. Dec 1989. 33p. (EPA–600/4-89/048A). Available from NTIS, PC A03/MF A01.

See also PB–90-150855.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. These reports summarize the proximity of sanitary landfills in Georgia to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.) and present data on the individual landfills. The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. The nearness or proximity of the sanitary landfills to wetlands and deepwater habitats was determined by drawing three concentric regions around the point representing the location of each landfill. The radii of the concentric regions were: 1/4 mile, 1/2 mile, and 1 mile. Most sanitary landfills in Georgia are located in or are close to either wetlands or deepwater habitats. All are located close to wetlands while one-third are close to deepwater habitats. These facilities have the potential to adversely affect sensitive ecosystems, such as wetlands and deepwater habitats, either through habitat alterations or through the migration of contaminants from sanitary landfills.

26818 (PB–90-150855/XAB) **Proximity of Georgia sanitary landfills to wetlands and deepwater habitats. Data on individual landfills.** Moerlins, J.E.; Herndon, R.C.; Lambou, V.W.; Gebhard, R.L. Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring Systems Lab. Dec 1989. 45p. (EPA–600/4-89/048B). Available from NTIS, PC A03/MF A01.

See also PB–90-150848.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. This report documents the proximity of sanitary landfills included in the study in Georgia to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.). The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. The nearness or proximity of the sanitary landfills to wetlands and deepwater habitats was determined by drawing three concentric regions around the point representing the location of each landfill. The radii of the concentric regions were: 1/4 mile, 1/2 mile, and 1 mile. A companion report summarizes the statewide results. The data on individual landfills include general facility/site data and wetlands/deepwater habitat data. These facilities have the potential to adversely affect sensitive ecosystems, such as wetlands and deepwater habitats, either through habitat alterations or through the migration of contaminants from sanitary landfills.

26819 (PB–90-150863/XAB) **Proximity of Florida sanitary landfills to wetlands and deepwater habitats. statewide results.** Herndon, R.C.; Moerlins, J.E.; Lambou, V.W.; Gebhard, R.L. Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring Systems Lab. Jan 1990. 33p. (EPA–600/4-89/041A). Available from NTIS, PC A03/MF A01.

See also PB–90-150871.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. These reports summarize the proximity of sanitary landfills in Florida to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.) and present data on the individual landfills. The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. The nearness or proximity of the sanitary landfills to wetlands and deepwater habitats was determined by drawing three concentric regions around the point representing the location of each landfill. The radii of the concentric regions were: 1/4 mile, 1/2 mile, and 1 mile. Most sanitary landfills in Florida are located in or are close to either wetlands or deepwater habitats. Most are located close to wetlands while approximately half are close to deepwater habitats. The facilities have the potential to adversely affect sensitive ecosystems, such as wetlands and deepwater habitats, either through habitat alterations or through the migration of contaminants from sanitary landfills.

26820 (PB–90-150871/XAB) **Proximity of Florida sanitary landfills to wetlands and deepwater habitats. Data on individual landfills.** Herndon, R.C.; Moerlins, J.E.; Lambou, V.W.; Gebhard, R.L. Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring Systems Lab. Jan 1990. 37p. (EPA–600/4-89/041B). Available from NTIS, PC A03/MF A01.

See also PB–90-150863.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. The report documents the proximity of sanitary landfills included in the study in Florida to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.). The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. The nearness or proximity of the sanitary landfills to wetlands and deepwater habitats was determined by drawing three concentric regions around the point representing the location of each landfill. The radii of the concentric regions were: 1/4 mile, 1/2 mile, and 1 mile. A companion report summarizes the statewide results. The data on individual landfills include general facilities/site data and wetlands/deepwater habitat data. The facilities have the potential to adversely affect sensitive ecosystems, such as wetlands and deepwater habitats, either through habitat alterations or through the migration of contaminants from sanitary landfills.

26821 (PB–90-150939/XAB) **Superfund Record of Decision (EPA Region 2): Preferred Plating, NY. (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 22 Sep 1989. 54p. (EPA/ROD/R–02-89/088). Available from NTIS, PC A04/MF A01.

The 0.5-acre Preferred Plating site is located in a light industrial area of Farmingdale, Suffolk County, New York. The site is bordered to the east and west by commercial and light industrial properties, to the north by a large wooded area, and to the south by a residential community and a U.S. Army facility. Between September 1951 and June 1976, Preferred Plating Corporation operated a metal treating facility that resulted in the generation, storage, and disposal of hazardous waste. Untreated waste water was discharged to four concrete leaching points directly behind the facility. Site investigations conducted by the Suffolk County Department of Health Services as early as 1953 revealed heavy metal contamination of ground water and cracked and leaking onsite leaching pits. Ground water is used for drinking water supplies by the entire population of both Nassau and Suffolk counties. The operable unit addresses the overall ground water contamination attributable to the site; a second operable unit will be undertaken to more fully characterize and identify any contaminated soil and to investigate potential upgradient sources of contamination.

26822 (PB–90-150947/XAB) **Superfund Record of Decision (EPA Region 4): Smith's Farm, Brooks, KY. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 99p. (EPA/ROD/R–04-89/052). Available from NTIS, PC A05/MF A01.

The Smith's Farm site is a 560-acre property in a rural area of Bullitt County, Kentucky. Within the 560-acre property there is a 37.5-acre landfill that, until recently, was permitted by the State for the disposal of solid waste. The owner of the landfill was cited at various times by the State for permit violations. The property also

includes an 80-acre upgradient of the permitted landfill on a mile-long ridge between two intermittent creeks where the unpermitted disposal of drums containing hazardous waste occurred over a 20-year period. EPA investigations from 1979 to 1984 resulted in the removal of 6,000 surface drums containing hazardous waste including PCB-contaminated waste. This remedy addresses contaminated onsite soil, sediment, and drums within the 80-acre area. A second operable unit will address the other suspected areas of drum disposal. The primary contaminants of concern affecting the soil and sediment are organics including PCBs and PAHs, and metals including lead.

26823 (PB–90-150954/XAB) **Superfund Record of Decision (EPA Region 2): Claremont Polychemical, New York (Second remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 22 Sep 1989. 57p. (EPA/ROD/R–02-89/090). Available from NTIS, PC A04/MF A01.

The Claremont Polychemical site is a 9.5-acre abandoned chemical production facility in central Long Island, Town of Oyster Bay, Nassau County, New York. Land use in the area is devoted primarily to light industrial and commercial operations. Contamination at the site took place between 1968 and 1980 and resulted from ink and pigment manufacturing operations, which generated wastes including organic solvents, resins, and wash wastes. The site consists of a one-story building with a contaminated sump, five 5,000-gallon wastewater treatment basins containing sludge, and six above-ground tanks, three of which still contain waste materials. The initial discovery of site contamination occurred in 1979 when the county found 2,000 to 3,000 waste drums, some uncovered and others leaking. The primary contaminants of concern in drummed and packaged liquids and solids, and in treatment basin sludge are VOCs including benzene, toluene, TCE, and PCE; other organics; and metals including arsenic, chromium, and lead.

26824 (PB–90-150970/XAB) **Superfund Record of Decision (EPA Region 10): Northside Landfill, Washington (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 30 Sep 1989. 124p. (EPA/ROD/R–10-89/019). Available from NTIS, PC A06/MF A01.

The 345-acre Northside Landfill is in a mixed residential and agricultural area, in the northwest corner of the city of Spokane, Spokane County, Washington. The landfill has been used since the 1930s by the city of Spokane and a variety of private and public haulers for disposal of residential and light commercial refuse. The landfill is divided into four disposal units: a refuse unit, a grease skimmings unit, an old open burn unit and a sewage sludge unit. Only the refuse unit is active; however, it is scheduled to close by 1992. The western one-third of the land fill lies over the large Spokane Valley-Rathdrum Prairie Aquifer (SVRPA). The SVRPA was designated as a sole source of water supply for the Spokane-Coeur d'Alene area by EPA in 1978. Investigations conducted in 1981 and 1983 indicated the presence of volatile organic compounds (VOCs) beneath the site and in offsite residential wells located northwest of the landfill. The city immediately supplied the 19 affected residences with bottled water and has since extended municipal water lines to the area. The primary contaminants of concern affecting the ground water are VOCs including PCE, TCA, and TCE. In addition, iron and lead exceed the secondary drinking water standards offsite.

26825 (PB–90-153677/XAB) **Superfund Record of Decision (EPA Region 1): Auburn Road Landfill, Londenderry, NH. (Second remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 192p. (EPA/ROD/R–01-89/042). Available from NTIS, PC A09/MF A01.

See also PB–87-190104. Portions of this document are not fully legible.

The Auburn Road Landfill site consists of four former disposal areas on 200 acres of land in Londenderry, Rockingham County, New Hampshire. The four disposal areas, referred to as the Old Town Dump (3 acres), the Tire Dump (4 acres), the Solid Waste Area (6 acres), and the Septage Lagoon (1 acre), are sources of soil and ground water contamination at the site. In 1979, after verifying that industrial wastes were being disposed of at the site, the State prohibited further disposal of drums. In 1986 EPA removed approximately 1,000 drums of waste materials from the site, the majority being removed from the Old Town Dump area. The first operable unit for the site was completed in December 1987, when all residences identified as being potentially impacted by site ground water contamination were connected to a local public water supply. The ROD represents the second and third operable units for the site and includes ground water remediation and reducing residual soil contamination which is a contamination source to ground water. The primary contaminants of concern affecting the soil and ground water are VOCs including benzene, toluene, TCE, and PCE; and metals including arsenic and lead.

26826 (PB–90-153685/XAB) **Superfund Record of Decision (EPA Region 5): Cross Brothers Pail (Pembroke), IL. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 28 Sep 1989. 79p. (EPA/ROD/R–05-89/106). Available from NTIS, PC A05/MF A01.

See also PB–85-249613. Portions of this document are not fully legible.

The Cross Brothers Pail site is a former pail and drum recycling operation located in Pembroke Township, Kankakee County, Illinois. The 20-acre site, approximately half of which was used for waste disposal, is in a semi-residential area interspersed with small farms. Recycling operations, which involved draining empty drums and pails containing paints, dyes, and inks on the ground, resulted in the formation of a waste residue layer approximately 6 inches thick over 10 acres of the property. In addition crushed pails and drums were buried in 10 trenches located around the site. Operations continued at the site from 1961 until 1980 when the State closed the site and ordered a cleanup. An Initial Remedial Measure was signed in 1985 which required clearing the disposal area of all vegetation and removing 6,438 tons of contaminated surficial soils, 542 drums containing wastes, and 572 empty drums. Ground water contamination is the principal threat at the site. The primary contaminants of concern affecting the soil and ground water are VOCs including benzene, PCE, TCE, toluene and xylenes; and other organics including PCBs.

26827 (PB–90-153693/XAB) **Superfund Record of Decision (EPA Region 3): Craig Farm Drum, Perry Township, PA. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 54p. (EPA/ROD/R–03-89/079). Available from NTIS, PC A04/MF A01.

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The Craig Farm Drum site covers approximately 117 acres near the village of Fredericksburg in Armstrong County, Pennsylvania. The area around the site is dominated by farmland and forest, and a creek crosses the southern portion of the site. The site consists of two abandoned strip mine pits which were later used for disposal of distillation residue containing resorcinol and other high polymers. From 1958 to 1963 the Koppers Chemical Co. disposed of 2,500 tons of resorcinol production residue in 55-gallon drums in the pits. The primary contaminants of concern affecting the soil and ground water are organics including benzene and phenol, inorganics, and metals including lead and chromium. The selected remedial action for the site includes the excavation of 32, 000 cubic yards of soil from the two disposal pits and surrounding area with onsite treatment using solidification; placement of treated soil in a newly excavated and lined onsite landfill followed by capping; passive collection of ground water using a seep interceptor system with offsite treatment; and performing a ground water verification study.

26828 (PB–90-153735/XAB) **Superfund Record of Decision (EPA Region 2): De Rewal Chemical, Hunterdon County, NJ. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 55p. (EPA/ROD/R–02-89/087). Available from NTIS, PC A04/MF A01.

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The De Rewal Chemical site is in Kingswood Township, Hunterdon County, New Jersey. The 3.7-acre site lies within the 100-year

floodplain of the Delaware River and consists of a former dumping area, a garage, a private residence, and a building formerly occupied by the De Rewal Chemical Company. Between 1970 and 1973 the De Rewal Chemical Company reportedly manufactured and stored a textile preservative and an agricultural fungicide onsite. The State discovered De Rewal Chemical Company's improper chemical handling practices in 1972 but was unsuccessful in forcing the company to comply with permit requirements. The De Rewal Chemical Company continued to improperly dump chemicals onsite including one incident in which a tank truck containing 3,000 to 5,000 gallons of highly acidic chromium solution was allowed to drain onto the soil and eventually to the Delaware River. In 1973 the State ordered the company to excavate and place contaminated soil on an impermeable liner. The company reportedly only placed a portion of the contaminated soil on an uncovered plastic sheet before filing for bankruptcy. The primary contaminants of concern affecting the soil and ground water are VOCs including PCE, TCE, and toluene; other organics including PAHs; and metals including chromium and lead.

26829 (PB–90-153750/XAB) **Superfund Record of Decision (EPA Region 1): Norwood PCB's, Norwood, MA. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 274p. (EPA/ROD/R–01-89/043). Available from NTIS, PC A12/MF A02.

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The 26-acre Norwood PCBs site consists of several industrial and commercial properties, parking areas, and vacant lots in Norwood, Norfolk County, Massachusetts. Site contamination originated from disposal practices of previous businesses, primarily electrical equipment manufacturing, that operated from the building now owned by Grant Gear Realty Trust. In April 1983 the State responded to a citizen report of previous industrial waste dumping at the site and took surficial soil and sediment samples which confirmed PCB contamination. In June 1983 EPA moved 500 tons of PCB-contaminated soil from the office park complex and Grant Gear properties and disposed of it offsite. The State implemented an Interim Remedial Measure in 1986 to limit access to areas with high surface contamination on the Grant Gear property by constructing a 1.5-acre cap. The primary contaminants of concern affecting soil, sediment, ground water, and building surfaces are VOCs including TCE and PCE; other organics including PCBs, PAHs, and phenols; and metals.

26830 (PB–90-155615/XAB) **Predicting subsurface contaminant transport and transformation: Considerations for model selection and field validation. Final report, October 1987-June 1989.** Weaver, J.; Enfield, C.; Yates, S.; Kreamer, D.; White, D. Environmental Protection Agency, Ada, OK (USA). Robert S. Kerr Environmental Research Lab. Aug 1989. 67p. (EPA–600/2-89/045). Available from NTIS, PC A04/MF A01.

Predicting subsurface contaminant transport and transformation requires mathematical models based on a variety of physical, chemical, and biological processes. The mathematical model is an attempt to quantitatively describe observed processes in order to permit systematic forecasting of cause and response relationships. The mathematical models and the computer codes which solve the differential equations are approximations of the systems being described. The validity of these approximations depends on the purposes of the calculation. The report describes several mass transport processes but does not attempt to describe transformation processes. The body of the report focuses on considerations for model implementation and the validity of the implementation.

26831 (PB–90-156233/XAB) **Exposure-assessment component of the Field Verification Program: Overview and data presentation.** Munns, W.R.; Paul, J.F.; Bierman, V.J.; Davis, W.R.; Galloway, W.B. Science Applications International Corp., Narragansett, RI (USA). Jun 1989. 278p. Available from NTIS, PC A13/MF A02.

The exposure assessment component of the aquatic portion of the Field Verification Program (FVP) related the source input of dredged material contaminants to corresponding concentration distributions in space and time in the vicinity of the disposal mound. The specific objectives for this component were to provide a description of the environmental exposure field at biological effects measurement stations in the water column (pelagic zone), in the sediments (benthic zone), and at the near-bottom/sediment-water interface (epibenthic zone); to relate the source (dredge disposal mound) to near-field exposure measurements using process models for the vertical transport of contaminants and particulate materials; and to determine the environmental processes controlling contaminant phase partitioning. The report provides an overview of the exposure assessment component of the aquatic portion of the FVP, and describes the methods used and results obtained from activities directed towards the first objective.

26832 (PB–90-157751/XAB) **Superfund Record of Decision (EPA Region 7): Hastings Gground water, Hasting, NW. (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 26 Sep 1989. 33p. (EPA/ROD/R–07-89/029). Available from NTIS, PC A03/MF A01.

The Hastings Ground Water Contamination site is a contaminated aquifer in the vicinity of the City of Hastings, Adams County, Nebraska. The site consists of several source areas, referred to as subsites, contaminated with various chlorinated volatile industrial chemicals. The Record of Decision addresses the Well Number 3 subsite which consists of a ground water plume contaminated with carbon tetrachloride emanating from a former grain storage facility. The State first identified volatile organic contamination in Well Number 3 in 1983. Between 1986 and 1989 EPA conducted a field investigation which identified the grain storage area as the source of ground water contamination probably resulting from accidental spills of liquid fumigants used during grain storage. This interim source control operable unit was developed to reduce the migration and volume of volatile contaminants present in the soil. The primary contaminants of concern in the soil which impact the ground water are VOCs including carbon tetrachloride and chloroform.

26833 (PB–90-157850/XAB) **Superfund Record of Decision (EPA Region 7): Kem-Pest Laboratories, MO. (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 81p. (EPA/ROD/R–07-89/031). Available from NTIS, PC A05/MF A01.

Portions of this document are not fully legible.

The Kem-Pest Laboratories site is a former pesticide manufacturing facility approximately 3 miles northeast of Cape Girardeau, Cape Girardeau County, Missouri. The 6-acre site is in a rural area devoted primarily to agricultural activities. Contamination at the site resulted from the manufacturing of pesticide products from 1965 until 1977. Production activities took place in an onsite concrete block formulation building. Sewage and plant wastes were disposed of in an onsite lagoon which was backfilled with clay in 1981. EPA investigations beginning in 1981 have identified pesticide and volatile and semi-volatile organic contamination in soil, sediment in drainage channels, and in groundwater. This operable unit addresses contaminated soil and sediment. Future operable units will address groundwater and the formulation building. The primary contaminants of concern affecting the soil and sediment are VOCs including xylenes, other organics including organochlorine and pesticides, and metals including arsenic.

26834 (PB–90-157892/XAB) **Superfund Record of Decision (EPA Region 3): New Castle Spill, New Castle, DE. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 28 Sep 1989. 48p. (EPA/ROD/R–03-89/077). Available from NTIS, PC A03/MF A01.

Portions of this document are not fully legible.

The New Castle Spill site is a former manufacturing facility 0.5 mile north of New Castle, Delaware, and is in the 100-year floodplain of the Delaware River. Commercial enterprises and residences neighbor the site and receive potable water from the deeper of the two aquifers underlying the site. The six-acre area associated with the site consists of municipal property, wetlands, and the Witco manufacturing facility which produced plastic foams using (2-chloropropyl)-phosphate. In 1977, because of dead grass near the facility's drum storage area, Witco investigated the area

and determined that four to five drums of tris had spilled and contaminated the soil and the shallow aquifer. The State subsequently pumped and discharged contaminated groundwater into adjacent wetlands. A 1988 remedial investigation revealed that there is no longer a source of contamination at the site and that tris has contaminated the shallow aquifer but not the deeper aquifer. This limited response action addresses the groundwater contamination in the shallow aquifer. The primary contaminant of concern affecting the groundwater is (2-chloropropyl)-phosphate.

26835 (PB–90-159245/XAB) **Development of purge and trap with whole-column cryotrapping for the analysis of ground water contaminated with organic compounds. Final report.** Pankow, J.F. Oregon Graduate Center, Beaverton, OR (USA). Dept. of Environmental Science and Engineering. 1989. 29p. Available from NTIS, PC A03/MF A01.

A method has been developed for the determination of volatile organic compounds in water. It involves the direct purging of a sample to a fused silica capillary column. As they are purged, the compounds are focused on a DB-624 column using whole-column cryotrapping (WCC). WCC at -90 to -80 C traps all of the purgeable priority pollutant compounds. After purging, the gas chromatography run is started immediately. The purge and whole column cryo-trapping (P/WCC) method is facilitated by the fact that water is relatively non-volatile. Advantages of P/WCC include: simplicity and therefore high reliability; low background contamination since no sorbent traps or multiport valves are needed; no need to retain very volatile compounds on an intermediate trap as in purge and trap; and very short run times.

26836 (PB–90-856667/XAB) **Radioactive waste disposal sites. January 1984-August 1989 (Citations from Pollution Abstracts). Report for January 1984-August 1989.** . National Technical Information Service, Springfield, VA (USA). Jan 1990. 71p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning disposal sites for radioactive waste materials. Studies on potential sites for nuclear waste disposal include environmental surveys, trace element migration studies, groundwater characterization, rock mechanics, public opinion, pilot studies, and economic considerations. Safety aspects and risks associated with radioactive waste disposal are also considered. Radioactive waste processing and containerization are referenced in related published bibliographies. (Contains 155 citations fully indexed and including a title list.)

26837 (PNL-SA–17635) **Hypothetical assessment of regional liming costs for the Adirondacks.** Tawil, J.J. (Research Enterprises, Inc., Richland, WA (USA)); Bold, F.C.; Britt, D.L.; Steiner, A.J.; Callaway, J.M. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 5p. Sponsored by U.S. DOE Energy Research; U.S. Department of the Interior. DOE Contract AC06-76RL01830. (CONF-900212–1: International conference on acidic deposition: state of science and technology, Hilton Head Island, SC (USA), 11-16 Feb 1990). Order Number DE90009174. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Previous studies of lake liming costs in the Adirondacks have developed methods for predicting liming costs for individual lakes and reported these costs both for representative and specific lakes in the region. This study develops a method for estimating lake liming costs for a large number of lakes. The specific objectives of this study consisted of developing a methodology for predicting regional lake liming costs that can be extended to other regions in the United States; developing total and marginal cost (i.e., supply) curves for liming and restocking lakes in the Adirondacks Lake region; and assessing the sensitivity of the total cost and supply curves in the Adirondack Lakes region to alternative selection criteria. Lake liming and restocking costs were estimated using a version of the DeAcid model, modified specifically for this study. 2 figs.

26838 (QME–PA-29) **Status of the acidity of the lakes of the Ottawa River basin.** Precipitations acides 2 EN/PA-29. Dupont, J. Quebec Ministere de l'Environnement, Ste-Foy, PQ (Canada). Mar 1988. 108p. Available from PC Que@'bec Ministe@'re de l'environnement, 3900, rue Marly, Ste Foy, PQ, CAN G1X 4E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

The Quebec Ministry of the Environment has conducted, an experimental study of 317 lakes located in the Outaovais region; the following results are based on this study. Of the 40,180 lakes counted in the hydrographic basis of the Ottawa River, 82.3% are located in areas where the rocks have only a small acid neutralizing capacity; the other lakes are located on carbonated rocks and are, therefore, less vulnerable to acid rain. If the 7,253 lakes of surface comprised between 10 and 1000 hectares which are located in the sensitive areas are considered, 23.3% have a pH lower than or equal to 5.5 and 62.5% have a pH lower than or equal to 6.0. The sulfate contribution from the atmosphere and from the hydrographic basin are responsible for the acidity of a large proportion of these lakes, as shown by the domination of the anions by sulfates in more than 77% of the lakes; also, the bicarbonate/sulfate ratio, which is usually larger than 1 in lakes not affected by airborne pollutants, is inferior to 1 in 84% of cases. The SIGMA/SLAM management model has been applied to the sample of 317 lakes so as to simulate the effect of a decrease of an increase in the sulfate content of the precipitations on the pH of these lakes. According to the results of the model, the presently accepted standard of 20 kg/hectare/y for the deposition of sulfates is too high to protect most of the sensitive lakes; nearly 40% of the lakes would reach a pH lower than 6, and 8.2%, a pH lower than 5.5. A standard of 15 kg/hectar/y would allow a large proportion of the currently affected lakes to recover.

26839 (SAND–89-2373C) **Use of large-scale transient stresses and a coupled adjoint-sensitivity/kriging approach to calibrate a groundwater-flow model at the WIPP [Waste Isolation Pilot Plant] site.** Beauheim, R.L. (Sandia National Labs., Albuquerque, NM (USA)); LaVenue, A.M. Sandia National Labs., Albuquerque, NM (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005117–4: GEOVAL '90, Stockholm (Sweden), 14-17 May 1990). Order Number DE90009307. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A coupled adjoint-sensitivity/kriging approach was used to calibrate a groundwater-flow model to 10 years of human-induced transient hydraulic stresses at the WIPP site in New Mexico, USA. Transmissivity data obtained from local-scale hydraulic tests were first kriged to define an initial transmissivity distribution. Steady-state model calibration was then performed employing adjoint-sensitivity techniques to identify regions where transmissivity changes would improve the model fit to the observed steady-state heads. Subsequent transient calibration to large-scale hydraulic stresses created by shaft construction and long-term pumping tests aided in the identification of smaller scale features not detected during steady-state calibration. This transient calibration resulted in a much more reliable and defendable model for use in performance-assessment calculations. 7 refs., 6 figs.

26840 (WSRC-RP–89-1085) **FTWORK: A three-dimensional groundwater flow and solute transport code.** Faust, C.R. (GeoTrans, Inc., Herndon, VA (USA)); Sims, P.N.; Spalding, C.P.; Andersen, P.F.; Stephenson, D.E. Westinghouse Savannah River Co., Aiken, SC (USA). Jan 1990. 294p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90008007. Available from NTIS, PC A13/MF A01 - OSTI; GPO Dep.

The three-dimensional, finite-difference model, FTWORK, may be used to simulate groundwater flow and solute transport processes in fully saturated porous media. The model solves the flow and transport equations separately. Transport mechanisms considered include: advection, hydrodynamic dispersion, adsorption, and radioactive decay. This version of FTWORK also provides for parameter estimation of the steady-state flow applications. Also included in this version is a subroutine that allows linkage with a particle tracking program, GEOTRACK. 20 refs., 51 figs., 31 tabs.

26841 (WSRC-RP–89-1172) **Suitability of the Hydropunch™ for assessing groundwater contaminated by volatile organics.** Bergren, C.L.; Tuckfield, R.C.; Park, N.M. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 16p. Sponsored by U.S. DOE

Defense Programs. DOE Contract AC09-89SR18035. (CONF-9005149–2: 4. national outdoor action conference, Las Vegas, NV (USA), 14-17 May 1990). Order Number DE90009275. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Hydropunch is a groundwater sampling device developed for rapid and cost effective collection of groundwater samples from any depth. A study was conducted at the Savannah River Site to evaluate the tool's performance in collecting groundwater samples for waste site characterizations. Hydropunch samples were collected from two locations adjacent to each of five wells monitoring groundwater contaminated by volatile organics. At each location, Hydropunch samples were taken at three evenly distributed depths within the interval corresponding to the screen zone of the adjacent monitoring well. Groundwater samples were collected concurrently from the monitoring wells. All samples were analyzed using a Gas Chromatograph/Mass Spectrometer to detect any of twenty-five volatile organic contaminants. This field evaluation demonstrates that the Hydropunch is a reliable screening tool for determining the distribution and concentrations of volatile organic contaminants in groundwater. 6 refs., 3 figs., 3 tabs.

26842 Shredders and riparian vegetation. Cummins, K.W. (Univ. of Maryland, Frostburg (USA)); Wilzbach, M.A.; Gates, D.M.; Perry, J.B.; Taliaferro, W.B. *Bioscience (USA)*, 39(1): 24-30 (Jan 1989). DOE Contract FG05-85ER60301.

Stream invertebrates that feed on leaf litter are intimately tied to the nature and timing of the litter input. These invertebrates are called shredders; they consume streamside, riparian litter that has become trapped in the stream channel. This plant litter accumulates at the leading edge of obstructions in the current and settles out in pools, alcoves, and other depositional zones. Given the extensive literature that has accumulated over the last 20 years, researchers can now develop a general, testable model that relates riparian plant communities to the stream shredders, which depend upon litter derived from those communities.

26843 Selenate removal from waste water. Oremland, R.S. To Forest Service, Washington, DC (US). USA Patent Application 7-428,699. 30 Oct 1989. 34p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

An efficient process for removing oxyanions of selenium by selenate-respiring microorganisms may be obtained according to the invention by reducing the nitrate concentration well below 1 mM. In the process according to the invention, the required lowering of the nitrate concentration in selenium- and nitrate- containing waste water may be accomplished by employing a nitrate utilizing biomass under aerobic conditions in a first treatment zone to remove nitrate. The efficiency of the process is further enhanced by seeding the treatment zone where the microbial respiratory removal of oxyanions of selenium from waste water takes place with a culture of microorganisms enriched for selenium respiring microorganisms. Additional improvement of the process according to the invention may be obtained by adapting the seed culture of microorganisms enriched for selenium respiring microorganisms to the chemical conditions.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

Refer also to citation(s) 26306, 26335, 26344, 26346, 26350, 26352, 26354, 26361, 26372, 27104, 27105, 27185

26844 (ENEA-RT-TIB–89-46) **Remote sensing for contact sport: Energy consumption evalutation. Progress report No 1. Preliminary screening.** Sacripanti, A.; Faina, M.; Fabbri, M.; Rossi, L. ENEA, Rome (Italy). Direzione Sicurezza Nucleare e Protezione Sanitaria; ENEA, Casaccia (Italy). Dipt. Tecnologie Intersettoriali di Base. Nov 1989. 23p. (In Italian). (RT/TIB–89-46). Order Number DE90764293. Available from NTIS (US Sales Only), PC A03/MF A01.

For the first time in Italian research on real condition energy consumption by atheletes participating in contact sports, remote sensing techniques were employed to obtain original quantitative data and perform energy analyses. Thermal data were obtained with the use of an AGA-Thermovision 780, high sensitivity, wide field, passive system for the formation of thermal images. Oxygen consumption data were obtained with the use of DATASPIR and JAEGER instruments. The thermograms were elaborated by means of the ENEA (Italian Commission for Alternative Energy Sources) digital imagery system.

26845 (ORNL–6604) **Biology Division progress report for period of October 1, 1988–September 30, 1989.** Oak Ridge National Lab., TN (USA). Feb 1990. 151p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010225. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The Biology Division of the Oak Ridge National Laboratory is one component of the Department of Energy's intramural program in life sciences. With respect to experimental biology, the congressionally mandated mission of this Office is to study adverse health effects of energy production and utilization. Within this stated broad mission, common themes among the research programs of the Biology Division are interactions of animals, cells, and molecules with their respective environments. Investigations focus on genetic and somatic effects of radiation and chemicals. Goals include identification and quantification of these effects, elucidation of pathways by which the effects are expressed, assessment of risks associated with radiation and chemical exposures, and establishment of strategies for extrapolation of risk data from animals to humans. Concurrent basic studies in genetics, biochemistry, molecular biology, and cell biology illuminate normal life processes as prerequisites to comprehending mutagenic and carcinogenic effects of environmental agents. This Progress Report is intended to provide both broad perspectives of the Division's research programs and synopses of recent achievements. Readers are invited to contact individual principal investigators for more detailed information, including reprints of publications. 120 refs.

5501 Behavioral Biology

Refer also to citation(s) 26761

5502 Biochemistry

Refer also to citation(s) 26306, 26353, 26845, 26880

26846 (AD-A–216150/3/XAB) **Molecular biological studies on the biogenesis of human cholinesterases in vivo and as directed by cloned cholinesterase DNA sequences. Midterm Report 25, September 1987-24 March 1989.** Soreq, H. Hebrew Univ., Jerusalem (Israel). 1 Apr 1989. 90p. Available from NTIS, PC A05/MF A01.

In order to study the multileveled regulation of the human cholinesterase genes and their protein products, the cDNAs encoding for butyrylcholinesterase and acetylcholinesterase in several human tissues were isolated and compared to each other and to other cDNAs encoding related proteins. Xenopus oocytes were used to express the synthetic mRNA for butyrylcholinesterase alone or with tissue mRNAs. Cross-homologies and structural differences between cholinesterases were revealed by antibodies against bacterially produced butyrylcholinesterase polypeptides, which also react with the homologous thyroglobulin. In situ hybridization was employed to reveal the expression of cholinesterase mRNA in human oocytes. Amplification of the CHE gene was found in a family exposed to parathion as well as in blood cells from patients with leukemias or platelet disorders.

26847 (DOE/ER/13505–T1) **Mechanisms of inhibition of viral replication in plants: Progress report.** Cornell Univ., Ithaca, NY (USA). Dept. of Plant Pathology. [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13505. Order Number DE90008988. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have made a number of interesting observations of importance to the fields of virology and plant molecular biology. Topics

include the genome of cucumber mosaic virus (CMV), recombination of the CMV genome, transgenic plants and viral movement genes, mapping resistance breakage sequences in the tomato mosaic virus (TMV) genome, and mapping pathogeneticity domains and viral RNA heterogeneity. 1 fig., 1 tab.

26848 (DOE/OR/00033–T437) **A study of nitrification and denitrification in the Canal de una Quebrada Tropical in the national forest of the Caribbean, Rio Grande, Puerto Rico.** Berlingeri Santiago, D.S. Puerto Rico Univ., San Juan (Puerto Rico). Apr 1989. 56p. (In Spanish). Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-76OR00033. Order Number DE90007747. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

I studied part of the cycle of nitrogen in the Quebrada Toronja, localized in the National Forest of the Caribbean, in Rio Grande, Puerto Rico. I took samples of water, leaves, and sediment of the area, and added known concentrations of ammonia and nitrate. From these samples, I determined the change in concentration of the prepared compound, at different times, to determine if nitrification and denitrification activity occurred. In the samples with ammonia added, I determined the concentration of nitrates in addition. The results and discoveries did not reflect activity of utilization or conversion of the compounds in the samples of water only. The leaves presented nitrification in the early hours, and later I observed chemical activity. I observed the utilization of nitrate in the leaves, only in low concentrations. In the sediment samples, I observed biological activity at low levels of concentration, but the changes to high concentrations are attributed principally to chemical factors rather than biological. 54 refs., 9 figs.

26849 (LA-UR–90-758) **High-speed DNA sequencing: An approach based upon fluorescence detection of single molecules.** Jett, J.H.; Keller, R.A.; Martin, J.C.; Marrone, B.L.; Moyzis, R.K.; Ratliff, R.L.; Seitzinger, N.K.; Shera, E.B.; Stewart, C.C. Los Alamos National Lab., NM (USA). [1989]. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-8906159–4: 6. conversation in the discipline biomolecular stereodynamics, Albany, NY (USA), 6-10 Jun 1989). Order Number DE90008948. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document discusses the development of a laser based technique for the rapid sequencing of large fragments of DNA based upon the detection of single, fluorescently tagged nucleotides cleaved from a single DNA fragments. Demonstrated is significant progress on several of the important steps of this technique. The projected rate of sequencing is several hundred bases per second which is orders of magnitude faster than existing methods. Once developed, this technology could be utilized by investigators for rapid sequencing of genetic material from virtually any source. 24 refs., 4 figs.

26850 (LBL–28620) **Binding modes and dynamics of distamycin A with several A-T-rich oligomers by two-dimensional NMR.** Pelton, J.G. Lawrence Berkeley Lab., CA (USA). Jan 1990. 247p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90009207. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

Nuclear Overhauser effect spectroscopy has been used to identify the binding modes and to probe the dynamics of distamycin A in complexes with $d(CGCGAATTCGCG)_2$, d(CGCAAATTGGC):d(GCCAATTTGCG), and $d(CGCAAATTTGCG)_2$. Distamycin A binds to the minor-groove of the AATT segment of the $d(CGCGAATTCGCG)_2$ duplex. The binding site is characterized by drug-DNA van der Waals contacts, three-center hydrogen bonds, and stacking of sugar O4′ atoms over each of the drug pyrrole rings. The drugs are in close contact with the DNA and one another. Distamycin A binds in one-drug and symmetric two-drug binding modes with $d(CGCAAATTTGCG)_2$. Energy refinement suggests that electrostatic interactions, intermolecular hydrogen bonds, and stacking interactions contribute to stabilization of these complexes. 80 refs., 38 figs., 14 tabs.

26851 (ORNL/TM–11475) **Habitat selection by kokanee salmon and smallmouth bass in thermally heterogeneous environments: The importance of growth maximization to diel habitat shifts.** Bevelhimer, M.S. (Oak Ridge National Lab., TN (USA)); Adams, S.M.; Gross, L.J. Oak Ridge National Lab., TN (USA). Feb 1990. 180p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007991. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

Environmental Sciences Division Publication No. 3463. Thesis. Submitted by M.S. Bevelhimer to University of Tennessee.

Diel habitat shifts consisting of vertical or horizontal movements are common in both marine and freshwater fishes. Hypotheses proposed to explain this behavior include maximizing food consumption, minimizing risk of predation, and maximizing bioenergetic efficiency. The bioenergetic hypothesis is often considered under conditions of thermal heterogeneity within the environment. The general objective of this study was to evaluate the importance of bioenergetic efficiency as an influence on habitat selection and diel habitat shifts of two fishes. 98 refs., 51 figs., 24 tabs.

26852 **Isolation and characterization of an archaebacterial viruslike particle from Methanococcus voltae A3.** Wood, A.G. (Univ. of Illinois, Urbana (USA)); Konisky, J.; Whitman, W.B. *Journal of Bacteriology (USA)*, 171(1): 93-98 (Jan 1989). DOE Contract FG02-84ER13241.

Small amounts of 23-kilobase covalently closed circular DNA molecule were isolated from unwashed cells of Methanococcus voltae A3. Further investigation indicated the presence of greater quantities of the circular DNA in the culture supernatant, complexed with protein in a manner rendering the DNA resistant to DNase. Electron-microscopic examination of supernatant material revealed the presence of particles which morphologically resemble virus. Phenol extraction of viruslike particle preparations resulted in the recovery of DNase-sensitive open-circular DNA molecules. As many as 30 viruslike particles per cell were recovered from some cultures. Hybridization data clearly indicated the presence of a chromosomally integrated copy of the viruslike particle DNA. Although M. voltae PS was not observed to produce viruslike particles, DNA homologous to the viruslike particle DNA was detected in its chromosome. A mutant of M. voltae A3 was isolated which produced no particles; its DNA was deleted for 80% of the integrated viruslike particle DNA. Despite any similarities to lysogenic bacteriophages of eubacteria, neither infectivity nor inducibility of the viruslike particles could by demonstrated.

26853 **A general method for site-specific incorporation of unnatural amino acids into proteins.** Noren, C.J. (Lawrence Berkeley Lab., CA (USA)); Anthony-Cahill, S.J; Griffith, M.C.; Schultz, P.G. *Science (Washington, D.C.) (USA)*, 244(4901): 182-188 (14 Apr 1989). DOE Contract AC03-76SF00098.

A new method has been developed that makes it possible to site-specifically incorporate unnatural amino acids into proteins. Synthetic amino acids were incorporated into the enzyme β-lactamase by the use of a chemically acylated suppressor transfer RNA that inserted the amino acid in response to a stop codon substituted for the codon encoding residue of interest. Peptide mapping localized the inserted amino acid to a single peptide, and enough enzyme could be generated for purification to homogeneity. The catalytic properties of several mutants at the conserved Phe^{66} were characterized. The ability to selectively replace amino acids in a protein with a wide variety of structural and electronic variants should provide a more detailed understanding of protein structure and function. 45 refs., 7 figs., 1 tab.

26854 **Biochemistry of platelet-activating factor: A unique class of biologically active phospholipids.** Snyder, F. (Oak Ridge Associated Univ., TN (USA)). *Proceedings of the Society for Experimental Biology and Medicine (USA)*, 190(2): 125-135 (1989).

This brief overview describes the chemical features of this unique bioactive phospholipid that possesses biologic properties identical to platelet-activating factor (PAF) and an antihypertensive polar renal lipid (APRL). The current understanding of PAF metabolism and its regulation are emphasized, particularly in the context of explaining the enzymatic source of PAF in physiologic vs pharmacologic processes. Also included are brief accounts of the biologic properties, structural-functional relationships, antagonists, receptors and mode of action of PAF.

26855 Identification and isolation of genes essential for H_2 oxidation in Rhodobacter capsulatus. Xu, H.W. (Univ. of Missouri-Columbia (USA)); Love, J.; Borghese, R.; Wall, J.D. *Journal of Bacteriology (USA)*, 171(2): 714-721 (Feb 1989). DOE Contract FG02-87ER13713.

Mutants of Rhodobacter capsulatus unable to grow photoautotrophically with H_2 and CO_2 were isolated. Those lacking uptake hydrogenase activity as measured by H_2-dependent methylene blue reduction were analyzed genetically and used in complementation studies for the isolation of the wild-type genes. Results of further subcloning and transposon Tn5 mutagenesis suggest the involvement of a minimum of five genes. Hybridization to the 2.2-kilobase-pair SstI fragment that lies within the coding region for the large and small subunits of Bradyrhizobium japonicum uptake hydrogenase showed one region of strong homology among the R. capsulatus fragments isolated, which we interpret to mean that one or both structural genes were among the genes isolated.

26856 Cloning, sequencing and characterization of the principal acid phosphatase, the phoC$^+$ product, from Zymomonas mobilis. Pond, J.L. (Univ. of Florida, Gainesville (USA)); Eddy, C.K.; Mackenzie, K.F.; Conway, T.; Borecky, D.J.; Ingram, L.O. *Journal of Bacteriology (USA)*, 171(2): 767-774 (Feb 1989). DOE Contract FG05-86ER13575.

The Zymomonas mobilis gene encoding acid phosphatase, phoC, has been cloned and sequenced. The gene spans 792 base pairs and encodes an M_r 28,988 polypeptide. This protein was identified as the principal acid phosphatase activity in Z. mobilis by using zymograms and was more active and magnesium ions than with zinc ions. Its promoter region was similar to the -35 pho box region of the Escherichia coli pho genes as well as the regulatory sequences for Saccharomyces cerevisiae acid phosphatase (PH05). A comparison of the gene structure of phoC with that of highly expressed Z. mobilis genes revealed that promoters for all genes were similar in degree of conservation of spacing and identity with the proposed Z. mobilis consensus sequence in the -10 region. The phoC gene contained a 5′ transcribed terminus which was AT rich, a weak ribosome-binding site, and less biased codon usage than the highly expressed Z. mobilis genes.

26857 Altered chloroplast structure and function in a mutant of Arabidopsis deficient in plastid glycerol-3-phosphate acyltransferase activity. Kunst, L. (Michigan State Univ., East Lansing (USA)); Somerville, C.; Browse, J. *Plant Physiology (USA)*, 90(3): 846-853 (Jul 1989). DOE Contract AC02-76ER01338.

Mutants of Arabidopsis thaliana deficient in plastid glycerol-3-phosphate acyltransferase activity have altered chloroplast membrane lipid composition. This caused an increase in the number of regions of appressed membrane per chloroplast and a decrease in the average number of thylakoid membranes in the appressed regions. The net effect was a significant decrease in the ratio of appressed to nonappressed membranes. A comparison of 77 K fluorescence emission spectra of thylakoid membranes from the mutant and wild type indicated that the ultrastructural changes were associated with an altered distribution of excitation energy transfer from antenna chlorophyll to photosystem II and photosystem I in the mutant. The changes in leaf lipid composition did not significantly affect growth or development of the mutant under standard conditions. However, at temperatures above 28°C the mutant grew slightly more rapidly than the wild type, and measurements of temperature-induced fluorescence yield enhancement suggested an increased thermal stability of the photosynthetic apparatus of the mutant. These effects are consistent with other evidence suggesting that membrane lipid composition is an important determinant of chloroplast structure but has relatively minor direct effects on the function of the membrane proteins associated with photosynthetic electron transport.

26858 A mutant of Arabidopsis deficient in desaturation of palmitic acid in leaf lipids. Kunst, L. (Michigan State Univ., East Lansing (USA)); Somerville, C.; Browse, J. *Plant Physiology (USA)*, 90(3): 943-947 (Jul 1989). DOE Contract AC02-76ER01338.

The overall fatty acid composition of leaf lipids in a mutant of Arabidopsis thaliana was characterized by elevated amounts of palmitic acid and a decreased amount of unsaturated 16-carbon fatty acids as a consequence of a single nuclear mutation. Quantitative analysis of the fatty acid composition of individual lipids suggested that the mutant is deficient in the activity of a chloroplast ω9 fatty acid desaturase which normally introduces a double bond in 16-carbon acyl chains esterified to monogalactosyldiacylglycerol (MGD). The mutant exhibited an increased ratio of 18- to 16-carbon fatty acids in MGD due to a change in the relative contribution of the prokaryotic and eukaryotic pathways of lipid biosynthesis. This appears to be a regulated response to the loss of chloroplast ω9 desaturase and presumably reflects a requirement for polyunsaturated fatty acids for the normal assembly of chloroplast membranes. The reduction in mass of prokaryotic MGD species involved both a reduction in synthesis of MGD by the prokaryotic pathway and increased turnover of MGD molecular species which contain 16:0.

26859 Properties of a Pseudomonas stutzeri outer membrane channel-forming protein (NosA) required for production of copper-containing N_2O reductase. Lee, H.S. (Univ. of California, Davis (USA)); Ingraham, J.L.; Hancock, R.E.W. *Journal of Bacteriology (USA)*, 171(4): 2096-2100 (Apr 1989). DOE Contract FG03-85ER13356.

A protein (NosA) in the outer membrane of Pseudomonas stutzeri that is required for copper to be inserted into N_2O reductase has been extracted and purified to homogeneity. The purified protein could form channels in black lipid bilayers. Line N_2O reductase, NosA contained copper and was only made anaerobically. In contrast to N_2O reductase, its synthesis was repressed by exogenous copper (but not by Mn, Co, Ni, Zn, or Fe). Also in contrast to N_2O reductase, NosA homologs were not immunologically detectable in Pseudomonas aeruginosa, Pseudomonas mendocina, Pseudomonas alcaligenes, or other strains of P. stutzeri.

26860 A perspective of the binding change mechanisms for ATP synthesis. Boyer, P.D. (Univ. of California, Los Angeles (USA)). *FASEB Journal (Federation of American Societies for Experimental Biology) (USA)*, 3(10): 2164-2178 (Aug 1989). DOE Contract FG03-88ER13845.

An overview of research in the field of bioenergetics that led to the development of the binding change mechanism for ATP synthesis is presented, with emphasis on research from the author's laboratory. The text follows closely the Rose Award Lecture given at the 1989 meeting of the American Society for Biochemistry and Molecular Biology. Remarkable advances have revealed that the ubiquitous membrane-bound ATP synthase has unusual composition and properties. The enzyme complex has 1, 2, 3, or 9-19 copies of eight or more protein subunits. The catalytic sites are located on three copies of an approximately 55-kDa subunit. It has the strongest positive catalytic cooperativity known for any enzyme. Examples are given of selected experimental results that have provided insights into its mechanism. These include demonstration of the characteristics, location, and function of catalytic and noncatalytic adenine nucleotide binding sites and the incisive information provided by measurement of phosphate oxygen exchanges and distribution of ^{18}O in ATP or P_i formed by catalysis. Research from various laboratories gives support to the binding change mechanism in which energy from proton translocation serves principally to promote release of tightly bound ATP, with sequential participation of three catalytic sites. Some speculative suggestions about a rotational catalysis and about the different forms assumed by the ATPase are included.

26861 Cloning, nucleotide sequence, and mutagenesis of a gene (irpA) involved in iron-deficient growth of the cyanobacterium Synechococcus sp. strain PCC7942. Reddy, K.J. (Univ. of Missouri, Columbia (USA)); Bullerjahn, G.S.; Sherman, D.M.; Sherman, L.A. *Journal of Bacteriology (USA)*, 170(10): 4466-4476 (Oct 1988). DOE Contract FG02-86ER13516.

We describe the cloning and sequencing of a gene from the cyanobacterium Synechococcus sp. strain PCC7942, designated irpA (iron-regulated protein A), that encodes for a protein involved in iron acquisition or storage. Polyclonal antibodies raised against proteins which accumulate during iron-deficient growth were used as probes to isolate immunopositive clones from a λgt11 genomic expression library. The clone, designated λgtAN26, carried a 1.7-kilobase (kb) chromosomal DNA insert and was detected by

cross-reactivity with antibody against a 36-kilodalton protein. It was possible to map a 20-kb portion of the chromosome with various DNA probes from λgt11 and λEMBL-3 clones, and Southern blot analysis revealed that the irpA gene was present in a single copy and localized within a 1.7-kb PstI fragment. DNA sequencing revealed an open reading frame of 1,068 nucleotides capable of encoding 356 amino acids which yields a protein with a molecular weight of 38,584. The hydropathy profile of the polypeptide indicated a putative N-terminal signal sequence of 44 amino acid residues. IrpA is a cytoplasmic membrane protein as determined by biochemistry and electron microscopy immunocytochemistry. The upstream region of the irpA gene contained a consensus sequence similar to the aerobactin operator in Escherichia coli.

26862 Isolation, hyperexpression, and sequencing of the aceA gene encoding isocitrate lyase in Escherichia coli. Matsuoka, M. (Washington State Univ., Pullman (USA)); McFadden, B.A. *Journal of Bacteriology (USA),* 170(10): 4528-4536 (Oct 1988). DOE Contract FG06-88ER13923.

A structural gene for isocitrate lyase was isolated from a cosmid containing an ace locus of the Escherichia coli chromosome. Cloning and expression under control of the tac promoter in a multicopy plasmid showed that a 1.7-kilobase-pair DNA segment was sufficient for complementation of an aceA deletion mutation and overproduction of isocitrate lyase. DNA sequence analysis of the cloned gene and N-terminal protein sequencing of the cloned and wild-type enzymes revealed an entire aceA gene which encodes a 429-amino-acid residue polypeptide whose C-terminus is histidine. The deduced amino acid sequence for the 47.2-kilodalton subunit of E. coli isocitrate lyase could be aligned with that for the 64.8-kilodalton subunit of the castor bean enzyme with 39% identity except for limited N- and C-terminal regions and a 103-residue stretch that was unique for the plant enzyme and started approximately in the middle of that peptide.

26863 Structure and comparative analysis of the genes encoding component C of methyl coenzyme M reductase in the extremely thermophilic archaebacterium Methanothermus fervidus. Weil, C.F. (The Ohio State Univ., Columbus (USA)); Cram, D.S.; Sherf, B.A.; Reeve, J.N. *Journal of Bacteriology (USA),* 170(10): 4718-4726 (Oct 1988). DOE Contract FG02-87ER13731.

A 6-kilobase-pair (kbp) region of the genome of the extremely thermophilic archaebacterium Methanothermus fervidus which encodes the α, β, and γ subunit polypeptides of component C of methyl coenzyme M reductase was cloned and sequenced. Genes encoding the β (mcrB) and γ (mcrG) subunits were separated by two open reading frames (designated mcrC and mcrD) which encode unknown gene products. The M. fervidus genes were preceded by ribosome-binding sites, separated by short A+T-rich intergenic regions, contained unexpectedly few NNC codons, and exhibited inflexible codon usage at some locations. Sites of transcription initiation and termination flanking the mcrBDCGA cluster of genes in M. fervidus were identified. The sequences of the genes, the encoded polypeptides, and transcription regulatory signals in M. fervidus were compared with the functionally equivalent sequences from two mesophilic methanogens (Methanococcus vannielii and Methanosarcina barkeri) and from a moderate thermophile (Methanobacterium thermoautotrophicum Marburg). The amino acid sequences of the polypeptides encoded by the mcrBCGA genes in the two thermophiles were approximately 80% identical, whereas all other pairs of these gene products contained between 50 and 60% identical amino acid residues. The mcrD gene products have diverged more than the products of the other mcr genes.

26864 Nucleotide sequence and transcriptional start site of the Methylobacterium organophilum XX methanol dehydrogenase structural gene. Machlin, S.M. (Univ. of Minnesota, Navarre (USA)); Hanson, R.S. *Journal of Bacteriology (USA),* 170(10): 4739-4747 (Oct 1988). DOE Contract AC02-82ER12029.

The nucleotide sequence of a cloned 2.5-kilobase-pair SmaI fragment containing the methanol dehydrogenase (MDH) structural gene from Methylobacterium organophilum XX was determined. A single open reading frame with a coding capacity of 626 amino acids (molecular weight, 66,000) was identified on one stand, and N-terminal sequencing of purified MDH revealed that 27 of these residues constituted a putative signal peptide. Primer extension mapping of in vivo transcripts indicated that the start of mRNA synthesis was 160 to 170 base pairs upstream of the ATG codon. Northern (RNA) blot analysis further demonstrated that the transcript was 2.1 kilobase pairs in length and therefore appeared to encode only MDH.

26865 Plasmid DNA from the acetotrophic methanogen Methanosarcina acetivorans. Sowers, K.R. (Univ. of California, Los Angeles (USA)); Gunsalus, R.P. *Journal of Bacteriology (USA),* 170(10): 4979-4982 (Oct 1988). DOE Contract FG03-86ER13498.

Nine acetotrophic and three methylotrophic strains of methane-producing bacteria were screened for the presence of plasmid DNA. Plasmids were detected in three marine isolates, including Methanosarcina acetivorans. All three plasmids appeared to be similar based on size and restriction site analyses. The plasmid from M. acetivorans, designated pC2A, was approximately 5.1 kilobase pairs in size and was estimated to be present in a low copy number of six plasmids per genome. Multimers were also observed. A restriction map was constructed. The function of this plasmid is cryptic.

26866 Bleomycin-induced DNA repair by Saccharomyces cerevisiae ATP-dependent polydeoxyribonucleotide ligase. Moore, C.W. (Univ. of Rochester School of Medicine and Dentistry, NY (USA)). *Journal of Bacteriology (USA),* 170(10): 4991-4994 (Oct 1988). DOE Contract AC02-76EV03490.

In contrast to ligase-deficient (cdc9) Saccharomyces cerevisiae, which did not rejoin bleomycin-induced DNA breaks, ligase-proficient (CDC9) yeast cells eliminated approximately 90% of DNA breaks within 90 to 120 min after treatment. Experimental conditions restricted enzymatic removal of the unusual 3′-phosphoglycolate terminal in DNA cleaved by bleomycin and involved doses producing equivalent numbers of DNA breaks or doses producing equivalent killing.

26867 Role of the Bradyrhizobium japonicum ntrC gene product in differential regulation of the glutamine synthetase II gene (glnII). Martin, G.B. (Michigan State Univ., East Lansing (USA)); Chapman, K.A.; Chelm, B.K. *Journal of Bacteriology (USA),* 170(12): 5452-5459 (Dec 1988).

We isolated the ntrC gene from Bradyrhizobium japonicum, the endosymbiont of soybean (Glycine max), and examined its role in regulating nitrogen assimilation. Two independent ntrC mutants were constructed by gene replacement techniques. One mutant was unable to produce NtrC protein, while the other constitutively produced a stable, truncated NtrC protein. Both ntrC mutants were unable to utilize potassium nitrate as a sole nitrogen source. In contrast to wild-type B. japonicum, the NtrC null mutant lacked glnII transcripts in aerobic, nitrogen-starved cultures. However, the truncated-NtrC mutant expressed glnII in both nitrogen-starved and nitrogen-excess cultures. Both mutants expressed glnII under oxygen-limited culture conditions and in symbiotic cells. These results suggest that nitrogen assimilation in B. japonicum is regulated in response to both nitrogen limitation and oxygen limitation and that separate regulatory networks exist in free-living and symbiotic cells.

26868 Alu polymerase chain reaction: A method for rapid isolation of human-specific sequences from complex DNA sources. Nelson, D.L. (Baylor College of Medicine, Houston, TX (USA)); Ledbetter, S.A.; Corbo, L.; Victoria, M.F.; Ramirez-Solis, R.; Webster, T.D.; Ledbetter, D.H.; Caskey, C.T. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(17): 6686-6690 (Sep 1989). DOE Contract FG05-88ER60692.

Current efforts to map the human genome are focused on individual chromosomes or smaller regions and frequently rely on the use of somatic cell hybrids. The authors report the application of the polymerase chain reaction to direct amplification of human DNA from hybrid cells containing regions of the human genome in rodent cell backgrounds using primers directed to the human Alu repeat element. They demonstrate Alu-directed amplification of a fragment of the human HPRT gene from both hybrid cell and cloned DNA and identify through sequence analysis the Alu repeats involved in this amplification. They also demonstrate the application of this

technique to identify the chromosomal locations of large fragments of the human X chromosome cloned in a yeast artificial chromosome and the general applicability of the method to the preparation of DNA probes from cloned human sequences. The technique allows rapid gene mapping and provides a simple method for the isolation and analysis of specific chromosomal regions.

26869 Differential regulation of oligodendrocyte markers by glucocorticoids: Post-transcriptional regulation of both proteolipid protein and myelin basic protein and transcriptional regulation of glycerol phosphate dehydrogenase. Kumar, S. (Univ. of California, Los Angeles (USA)); Cole, R.; Chiappelli, F.; De Vellis, J. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(17): 6807-6811 (Sep 1989).

During neonatal development glucocorticoids potentiate oligodendrocyte differentiation and myelinogenesis by regulating the expression of myelin basic protein, proteolipid protein, and glycerol phosphate dehydrogenase. The actual locus at which hydrocortisone exerts its developmental influence on glial physiology is, however, not well understood. Gycerol phosphate dehydrogenase is glucocorticoid-inducible in oligodendrocytes at all stages of development both in vivo and in vitro. In newborn rat cerebral cultures, between 9 and 15 days in vitro, a 2- to 3-fold increase in myelin basic protein and proteolipid protein mRNA levels occurs in oligodendrocytes within 12 hr of hydrocortisone treatment. Immunostaining demonstrates that this increase in mRNAs is followed by a 2- to 3-fold increase in the protein levels within 24 hr. In vitro transcription assays performed with oligodendrocyte nuclei show an 11-fold increase in the transcriptional activity of glycerol phosphate dehydrogenase in response to hydrocortisone but no increase in transcription of myelin basic protein or proteolipid protein. These results indicate that during early myelinogeneis, glucocorticoids influence the expression of key oligodendroglial markers by different processes: The expression of glycerol phosphate dehydrogenase is regulated at the transcriptional level, whereas the expression of myelin basic protein and proteolipid protein is modulated via a different, yet uncharacterized, mechanism involving post-transcriptional regulation.

5503 Cytology

26870 Genetic and pharmacological suppression of oncogenic mutations in RAS genes of yeast and humans. Schafer, W.R. (Lawrece Berkeley Lab., CA (USA)); Sterne, R.; Thorner, J.; Rine, J.; Kim, R.; Kim, S.H. *Science (Washington, D.C.) (USA),* 245(4916): 379-385 (28 Jul 1989).

The activity of an oncoprotein and the secretion of a pheromone can be affected by an unusual protein modification. Specifically, posttranslational modification of yeast-a-factor and Ras protein requires an intermediate of the cholesterol biosynthetic pathway. This modification is apparently essential for biological activity. Studies of yeast mutants blocked in sterol biosynthesis demonstrated that the membrane association and biological activation of the yeast Ras2 protein require mevalonate, a precursor of sterols and other isoprenes such as farnesyl pyrophosphate. Furthermore, drugs that inhibit mevalonate biosynthesis blocked the in vivo action of oncogenic derivatives of human Ras protein in the Xenopus oocyte assay. The same drugs and mutations also prevented the posttranslational processing and secretion of yeast a-factor, a peptide that is farnesylated. Thus, the mevalonate requirement for Ras activation may indicate that attachment of a mevalonate-derived (isoprenoid) moiety to Ras proteins is necessary for membrane association and biological function. These observations establish a connection between the cholesterol biosynthetic pathway and transformation by the ras oncogene and offer a novel pharmacological approach to investigating, and possibly controlling, ras-mediated malignant transformations. 50 refs., 3 figs., 3 tabs.

5504 Genetics

Refer also to citation(s) 26845, 26864, 26865, 27366

26871 (DOE/ER/60884–1) **The evolution of functionally organized communities: Theory and test: First year progress report.** Wilson, D.S. State Univ. of New York, Binghamton, NY (USA). Dept. of Biological Sciences. 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER60884. Order Number DE90009031. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This grant includes a number of projects that model evolution in structured populations. The focus is on processes that mold multispecies communities into functionally organized units– "superorganisms" in the same sense that individuals are "organisms." In addition, the same concepts can be applied to interactions among individuals in one-species social groups and interactions among genes within genotypes in gene pools. Indeed, many of my insights come from thinking about genetics interactions, social interactions, and multi-species interactions in a common framework. The projects reflect my hierarchical approach and publications will result that address all levels of the hierarchy.

26872 Biotechnology and the human geonome: Innovations and Impact. Basic Life Sciences Series. Woodhead, A.D.; Barnhart, B.J. (eds.). 175p. Plenum Press, New York, NY (US) (1988).

This book is principally a compilation of papers presented and a summary of roundtable discussions from a workshop on the human genome project for science writers at Brookhaven National Laboratory. The book will be of interest to those closely following the scientific and political history of genome projects, particularly the role of DOE, and those wishing to get an overview of genome programs in DOE. It should be purchased by libraries used by historians of science or by life scientists interested in applying physical and chemical techniques to answer molecular biological questions.

26873 Biotechnology in the environment. Klingmuller, W. (ed.). 193p. Springer-Verlag, Berlin (DE) (1988).

In 1986, the European Community established a Biotechnology Action Programme (BAP) involving 270 research contracts with laboratories in member states. This volume includes 21 reports from the first meeting of the subset of BAP contractors who are assessing the risks of genetically engineered organisms for environmental applications. To facilitate the exchange of views on the problem of safety evaluation in biotechnology, the presentations were not restricted to European Community-funded researchers. This book contains a mixture of both final and preliminary research reports as well as discussions of regulatory and policy issues. The research reports cover a variety of topics, although there is an emphasis on projects devoted to increasing the understanding of horizontal gene transfer. The book will be of interest of those who follow developments in the general subject of the environmental effects of genetically engineered organisms. Presumably, more results of the various BAP projects will be made available in later volumes.

26874 Computational analysis of genetic sequences. Goad, W.B. (Los Alamos National Lab., NM (USA)). *Annual Review of Biophysics and Biophysical Chemistry (USA),* 15: 79-95 (1986). DOE Contract W-7405-ENG-36.

Much computational processing of sequence data can be accomplished by applying the kinds of computational tools and processes widely used in text processing, perhaps specialized to sequences, but not necessarily so. A number of programs have been developed specifically to assist in assembling sequences from individually sequenced restriction fragments. As in the case of restriction sites, many sequence patterns of biological interest are essentially lexically defined, and can be dealt with by text-processing methods. However, the specifically biological problems of identifying evolutionary and functional relatedness between sequences have led to development of computational tools that go beyond anything from the text-processing area. I first sketch the use of text-processing tools in sequence analysis and then go on to methods for identifying homology and other relationships within and between sequences. I have tried to include the most active areas of actual application in molecular genetics, although the important area of secondary structure prediction is omitted.

26875 Chromosome classification and purification using flow cytometry and sorting. Gray, J.W. (Lawrence Livermore National Lab., CA (USA)); Langlois, R.G. *Annual Review of Biophysics and Biophysical Chemistry (USA),* 15: 195-235 (1986). DOE Contract W-7405-ENG-48.

The authors review here both the techniques and the applications of flow karyotyping and sorting, hereafter called flow cytogenetics. Included in our review of the techniques are the procedures for chromosome isolation and staining, the principles of flow cytometry and sorting, and the analytical procedures for classification of the chromosomes from flow cytometric data. Applications reviewed include classification of normal human chromosomes, identification of disease-linked structural and numerical aberrations, quantification of the frequency of structurally aberrant chromosomes as a measure of the extent of induced genetic damage, and purification of chromosomes of a single type to facilitate interpretation of flow karyotypes, gene mapping, and production of recombinant DNA libraries from chromosomes of a single type.

26876 **Mapping of functional regions of murine retrovirus long terminal repeat enhancers: Enhancer domains interact and are not independent in their contributions to enhancer activity.** Hollon, T. (Univ. of Washington, Seattle (USA)); Yoshimura, F.K. *Journal of Virology (USA),* 63(8): 3353-3361 (Aug 1989). DOE Contract FG06-86ER60409.

The authors have used deletion and recombinant long terminal repeat (LTR) mutants to examine enhancer activity differences between LTRs of the nonpathogenic Akv and the thymus lymphomagenic MCF13 murine retroviruses. Deletion mutant analysis revealed that major control regions for MCF13 and Akv LTR enhancer activity were similar but not identical. For both LTRs, major control regions were distinctly different in a murine T-cell and a fibroblast cell line. Recombinant enhancer analysis showed that LTRs could be divided into three regions capable of altering the level of enhancer activity through cooperative or antagonistic interaction. The contribution of each region to enhancer activity was dependent on its context with respect to the other regions. LTR enhancer function in different cell types appears to be the result of the interaction of enhancer modular elements.

26877 **Rapid and precise mapping of the Escherichia coli release factor genes by two physical approaches.** Lee, C.C. (Baylor College of Medicine, Houston, TX (USA)); Craigen, W.J.; Caskey, C.T.; Kohara, Yuji; Akiyama, Kiyotaka; Smith, C.L. *Journal of Bacteriology (USA),* 170(10): 4537-4541 (Oct 1988).

The termination of protein synthesis in Escherichia coli requires two codon-specific factors termed RF1 and RF2. RF1 mediates UAA- and UAG-directed termination, while RF2 mediates UAA- and UGA-directed termination. The genes encoding these factors have been isolated and sequenced, and RF2 was found to be encoded in two separate reading frames. The map position of RF1 has been reported as 27 min on the E. coli chromosome, while the RF2 map position has not yet been identified. In this study, two new and independent methods for gene mapping, using pulsed field gel electrophoresis and an ordered bacteriophage library spanning the entire chromosome, were used to localize the map position of the RF2 gene. In addition, the location of the RF1 gene was more precisely defined. The RF2 gene is located at 62.3 min on the chromosomes, while the RF1 gene is located at 26.7 min. This approach to mapping cloned genes promises to be a rapid and simple means for determining the gene order of the genome.

26878 **Identity of the 17-kilodalton protein, a DNA-binding protein from Escherichia coli, and the firA gene product.** Aasland, R. (Univ. of Bergen (Norway)); Holck, A.; Kleppe, K.; Coleman, J.; Raetz, C.R.H.; Smith, C.L. *Journal of Bacteriology (USA),* 170(12): 5916-5918 (Dec 1988). DOE Contract FG02-87ER60582.

The 17-kilodalton protein, a DNA-binding protein encoded by the skp gene of Escherichia coli, was found to be identical to histone-like protein I, the product of the firA gene. This conclusion was reached after chromosomal localization, using the recently constructed high- and low-resolution E. coli restriction maps, and by direct comparison of the N-terminal amino acid sequence of histonelike protein I and the 17-kilodalton protein.

26879 **Evolution of the vacuolar H^+-ATPase: Implications for the origin of eukaryotes.** Gogarten, J.P. (Univ. of California, Santa Cruz (USA)); Kibak, H.; Dittrich, P.; Taiz, L.; Bowman, E.J.; Bowman, B.J.; Manolson, M.F.; Poole, R.J.; Date, Takayasu; Oshima, Tairo. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(17): 6661-6665 (Sep 1989). DOE Contract FG03-84ER13245.

Active transport across the vaculoar components of the eukaryotic endomembrane system is energized by a specific vacuolar H^+-ATPase. The amino acid sequences of the 70- and 60-kDa subunits of the vacuolar H^+-ATPase are ≈25% identical to the β and α subunits, respectively, of the eubacterial-type F_0F_1-ATPases. The authors now report that the same vacuolar H^+-ATPase subunits are ≈50% identical to the α and β subunits, respectively, of the sulfur-metabolizing Sulfolobus acidocaldarius, an archaebacterium (Archaeobacterium). Moreover, the homologue of an 88-amino acid stretch near the amino-terminal end of the 70-kDa subunit is absent from the F_0F_1-ATPase β subunit but is present in the α subunit of Sulfolobus. Since the two types of subunits are homologous to each other, they must have arisen by a gene duplication that occurred prior to the last common ancestor of the eubacteria, eukaryotes, and Sulfolobus. Thus, the phylogenetic tree of the subunits can be rooted at the site where the gene duplication occurred. The inferred evolutionary tree contains two main branches: a eubacterial branch and an eocyte branch that gave rise to Sulfolobus and the eukaryotic host cell. The implication is that the vacuolar H^+-ATPase of eukaryotes arose by the internalization of the plasma membrane H^+-ATPase of an archaebacterial-like ancestral cell.

5505 Metabolism

Refer also to citation(s) 25624, 26346, 26937, 26949, 26950

26880 (DOE/ER/13495–T3) **[Anaerobic metabolism of aromatic compounds by phototrophic bacteria: Biochemical aspects]: Annual progress report, April 1, 1989–November 15, 1989.** Gibson, J. Cornell Univ., Ithaca, NY (USA). [1989]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13495. Order Number DE90009503. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Two aspects of the work proposed have received major emphasis during the period since the grant was activated: isolation and characterization of transposon insertion mutants of Rhodopseudomonas palusrtis defective in phototrophic growth on aromatic compounds, and attempts to purify and characterize the Coenzyme A ligase enzyme involved in activating 4-hydroxybenzoate. The HPLC apparatus was installed in August, and calibration of columns both for metabolite and for protein separations has been initiated. A start has also been made on synthesis of Coenzyme A thioesters of compounds that are potential intermediates in the anaerobic degradation pathways. 1 tab.

26881 **Mutants of Escherichia coli deficient in the fermentative lactate dehydrogenase.** Mat-Jan, F. (Southern Illinois Univ., Carbondale (USA)); Alam, K.Y.; Clark, D.P. *Journal of Bacteriology (USA),* 171(1): 342-348 (Jan 1989). DOE Contract AC02-82ER12095.

Mutants of Escherichia coli deficient in the fermentative NAD-linked lactate dehydrogenase (ldh) have been isolated. These mutants showed no growth defects under anaerobic conditions unless present together with a defect in pyruvate formate lyase (pfl). Double mutants (pfl ldh) were unable to grow anaerobically on glucose or other sugars even when supplemented with acetate, whereas pfl mutants can do so. The ldh mutation was found to map at 30.5 min on the E. coli chromosome. The ldh mutant FMJ39 showed no detectable lactate dehydrogenase activity and produced no lactic acid from glucose under anaerobic conditions as estimated by in vivo nuclear magnetic resonance measurements. We also found that in wild-type strains the fermentative lactate dehydrogenase was conjointly induced by anaerobic conditions and an acidic pH. Despite previous findings that phosphate concentrations affect the proportion of lactic acid produced during fermentation, we were unable to find any intrinsic effect of phosphate on lactate dehydrogenase activity, apart from the buffering effect of this ion.

5506 Medicine

Refer also to citation(s) 25908, 26955, 26966, 27185

26882 (DOE/ER/60868–1) **Molecular modeling in the development of metal radiopharmaceuticals: Progress report, July 15, 1989–July 14, 1990.** Green, M.A. Purdue Research Foundation, Lafayette, IN (USA). Mar 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER60868. Order Number DE90009507. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In year 1 of this project we have begun compilation of a structural library to serve as a data base containing descriptions of the molecular features of metal-labeled radiopharmaceuticals known to efficiently cross the blood-brain barrier. Such a data base is needed in order to identify structural features (size, shape, molecular surface areas and volumes) that are critical in allowing blood-brain barrier penetration. To date 9 metal complexes have been added to this structural library, along with 18 organic reference tracers, and numerous topological indices calculated. We have also begun to adapt the molecular modeling software in Polygen's QUANTA to allow performance of molecular mechanics calculations on metal complexes of radiopharmaceutical interest. Preliminary modeling studies of the radiopharmaceutical TcO(d,l-HMPAO), commercially marketed as an agent for studying cerebral perfusion, point to the possible role of subtle structural features in determining the unique and useful tissue pharmacokinetics exhibited by this tracer. 10 refs., 1 fig., 1 tab.

26883 (DOE/ER/60892–1) **Synthesis and in-vivo detection of boronated compounds for use in BNCT: Progress report, August 1, 1989–July 31, 1990.** Kabalka, G.W. Tennessee Univ. Hospital, Knoxville, TN (USA). Dept. of Radiology. Apr 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-89ER60892. Order Number DE90008974. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The primary objective of the DOE Program at the University of Tennessee Biomedical Imaging Center is the development of new technology to detect boron compounds in-vivo. The research focuses on the development of multinuclear magnetic resonance imaging (MRI) and spectroscopy (MRS) techniques for verifying and measuring BNCT agents in-vivo. A small but significant portion of the effort is directed toward the design of boron-containing neutron-capture-therapy agents. The UT – DOE program is unique in that it has access to two state-of-the-art multinuclear magnetic resonance imaging units housed in the Biomedical Imaging Center at the University of Tennessee Medical Center at Knoxville. Included in this report are two sections describing research accomplishments in multinuclear magnetic resonance imaging and synthesis of potential BNCT agents.

26884 (FRNC-TH–3461) **Gallium-67 scintigraphy and the Heart.** Garayt, D. Montpellier-1 Univ., 34 (France). 1987. 114p. (In French). Order Number DE90770436. Available from NTIS (US Sales Only), PC A06/MF A01.

Although gallium-67 was initially used for tumor imaging, clinical studies suggested its potential use as a method of detecting occult inflammatory lesions. The demonstration of diffuse myocardial uptake of gallium-67 during Lyme disease myocarditis is consistent with a pattern of diffuse myocarditis as seen in sarcoid myocarditis. Two cases are presented. A critical review of the various applications of gallium-67 scintigraphy to myocardium investigation is carried out. 80 refs.

26885 (FRNC-TH–3541) **Contrast agents in magnetic resonance imaging.** Karadjian, V. Paris-5 Univ., 75 (France). 1987. 48p. (In French). Order Number DE90770438. Available from NTIS (US Sales Only), PC A03/MF A01.

82 refs.

The origine of nuclear magnetic resonance signal is reminded and different ways for contrast enhancement in magnetic resonance imaging are presented, especially, modifications of tissus relaxation times. Investigations have focused on development of agents incorporating either paramagnetic ions or stable free radicals. Pharmacological and toxicological aspects are developed. The diagnostic potential of these substances is illustrated by the example of gadolinium complexes.

26886 (LA-UR–90-897) **Comparison of the algebraic reconstruction technique with the maximum entropy reconstruction technique for a variety of detection tasks.** Myers, K.J. (Food and Drug Administration, Rockville, MD (USA). Center for Devices and Radiological Health); Hanson, K.M. Los Alamos National Lab., NM (USA). [1990]. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900238–2: SPIE technical conference and exhibition on medical imaging, Newport Beach, CA (USA), 4-9 Feb 1990). Order Number DE90008933. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A method for comparing reconstruction algorithms is presented based on the ability to perform certain detection tasks on the resulting images. The reconstruction algorithms compared are the algebraic reconstruction technique and the maximum entropy reconstruction method. Task performance is assessed through a Monte Carlo simulation of the complete imaging process, including the generation of a set of object scenes, followed by data-taking, reconstruction, and performance of the specified task by a machine observer. For these detection tasks the figure of merit used for comparison is the detectability index. When each algorithm is run with approximately optimized parameters, these studies find comparable values for the detectability index. 19 refs., 6 figs., 2 tabs.

5507 Microbiology

Refer also to citation(s) 25257, 25406, 25627, 26849

26887 **Microbial life in deep terrestrial subsurfaces.** Fliermans, C.B. (Savannah River Laboratory, Aiken, SC (USA)); Balkwill, D.L. *Bioscience (USA),* 39(6): 370-377 (Jun 1989). DOE Contract AC09-76SR00001.

In 1985 the US Department of Energy (DOE) established a research program called Microbiology of the Deep Subsurface, which focuses on detecting microorganisms at greater depths, establishing fundamental scientific information, including their ecology, and exploring their potential use in clean-up of contaminated deep terrestrial sediments and groundwater environments associated with energy and defense production activities. This article describes the initial microbiological findings associated with three boreholes established at the Savannah River Plant (SRP) in Aiken, South Carolina, to a depth of 289 m beneath the soil surface and discusses how microorganisms may have come to live at these depths. Even more recent investigations have demonstrated the presence of diverse and abundant microbiological communities as deep as 520 m beneath the soil surface.

5510 Physiological Systems

26888 **Localization of the enzymes involved in the photoevolution of H_2 from acetate in Chlamydomonas reinhardtii.** Willeford, K.O. (Brandeis Univ., Waltham, MA (USA)); Gibbs, M. *Plant Physiology (USA),* 90(3): 788-791 (Jul 1989). DOE Contract AC02-76ER03231.

The localization of a series of enzymes involved in the anaerobic photodissimilation of acetate in Chlamydomonas reinhardtii F-60 adapted to a hydrogen metabolism was determined through the enzymatic analyses of the chloroplastic, cytoplasmic, and mitochondrial fractions obtained with a cellular fractionation procedure that incorporated cell wall removal by treatment with autolysine, digestion of the plasmalemma with the detergent digitonin, and fractionation by differential centrifugation on a Percoll step gradient. The sequence of events leading to the photoevolution of H_2 from acetate includes the conversion of acetate into succinate via the extraplastidic glyoxylate cycle, the oxidation of succinate to fumarate by chloroplastic succinate dehydrogenase, and the oxidation of malate to oxaloacetate in the chloroplast by NAD dependent malate dehydrogenase. The level of potential activity for the enzymes assayed were sufficient to accommodate the observed rate of the photoanaerobic dissimilation of acetate and the photoevolution of H_2.

26889 **Evidence for chloroplastic succinate dehydrogenase participating in the chloroplastic respiratory and photosynthetic electron transport chains of Chlamydomonas reinhardtii.** Willeford, K.O. (Brandeis Univ., Waltham, MA (USA)); Gombos, Z.; Gibbs, M. *Plant Physiology (USA),* 90(3): 1084-1087 (Jul 1989). DOE Contract AC02-76ER03231.

A method for isolating intact chloroplasts from Chlamydomonas reinhardtii F-60 was developed from the Klein, Chen, Gibbs, Platt-Aloia procedure. Protoplasts, generated by treatment with autolysine, were lysed with a solution of digitonin and fractionated on Percoll step gradients. The chloroplasts were assessed to be 90% intact (ferricyanide assay) and free from cytoplasmic contamination (NADP isocitrate dehydrogenase activity) and to range from 2 to 5% in mitochondrial contamination (cytochrome c oxidase activity). About 25% of the cellular succinate dehydrogenase activity (21.6 micromoles per milligram chlorophyll per hour, as determined enzymically) was placed within the chloroplast. Chloroplastic succinate dehydrogenase had a K_m for succinate of 0.55 millimolar and was associated with the thylakoidal material derived from the intact chloroplasts. This same thylakoidal material, with an enzymic assay of 21.6 micromoles per milligram chlorophyll per hour was able to initiate a light-dependent uptake of oxygen at a rate of 16.4 micromoles per milligram chlorophyll per hour when supplied with succinate and methyl viologen. Malonate was an apparent competitive inhibitor of this reaction. The succinate dehydrogenase activity present in the chloroplast was sufficient to account for the photoanaerobic rate of acetate dissimilation in H_2 adapted Chlamydomonas.

26890 **Enhanced thermal tolerance of photosynthesis and altered chloroplast ultrastructure in a mutant of Arabidopsis deficient in lipid desaturation.** Hugly, S. (Michigan State Univ., East Lansing (USA)); Kunst, L.; Somerville, C.; Browse, J. *Plant Physiology (USA),* 90(3): 1134-1142 (Jul 1989). DOE Contract AC02-76ER01338.

A mutant of Arabidopsis thaliana, deficient in activity of the chloroplast n-6 desaturase, accumulated high levels of $C_{16:1}$ and $C_{18:1}$ lipids and had correspondingly reduced levels of polyunsaturated lipids. The altered lipid composition of the mutant had pronounced effects on chloroplast ultrastructure, thylakoid membrane protein and chlorophyll content, electron transport rates, and the thermal stability of the photosynthetic membranes. The change in chloroplast ultrastructure was due to a 48% decrease in the amount of appressed membranes that was not compensated for by an increased amount of nonappressed membrane. This resulted in a net loss of 36% of the thylakoid membrane per chloroplast and a corresponding reduction in chlorophyll and protein content. Electrophoretic analysis of the chlorophyll-protein complexes further revealed a small decrease in the amount of light-harvesting complex. Relative levels of whole chain and protosystem II electron transport rates were also reduced in the mutant. In addition, the mutation resulted in enhanced thermal stability of photosynthetic electron transport. These observations suggest a central role of polyunsaturated lipids in determining chloroplast structure and maintaining normal photosynthetic function and demonstrate that lipid unsaturation directly affects the thermal stability of photosynthetic membranes.

26891 **Comparison of the lipid composition of oat root and coleoptile plasma membranes.** Sandstrom, R.P. (Portland State Univ., OR (USA)); Cleland, R.E. *Plant Physiology (USA),* 90(3): 1207-1213 (Jul 1989).

The total lipid composition of plasma membranes (PM), isolated by the phase partitioning method from two different oat (Avena sativa L.) tissues, the root and coleoptile, was compared. In general, the PM lipid composition was not conserved between these two organs of the oat seedling. Oat roots contained 50 mole % phospholipid, 25 mole % glycolipid, and 25 mole % free sterol, whereas comparable amounts in the coleoptile were 42, 39, and 19 mole %, respectively. Individual lipid components within each lipid class also showed large variations between the two tissues. Maximum specific ATPase activity in the root PM was more than double the activity in the coleoptile. Treatment of coleoptile with auxin for 1 hour resulted in no detectable changes in PM lipids or extractable ATPase activity. Differences in the PM lipid composition between the two tissues that may define the limits of ATPase activity are discussed.

5520 Public Health

Refer also to citation(s) 26654

5530 Agriculture and Food Technology

Refer also to citation(s) 26654, 26768

26892 **Genetic engineering of bacteria from managed and natural habitats.** Lindow, S.E. (Univ. of California, Berkeley (USA)); Panopoulos, N.J.; McFarland, B.L. *Science (Washington, D.C.) (USA),* 244(4910): 1300-1307 (16 Jun 1989). DOE Contract FG03-86ER13518.

The genetic modification of bacteria from natural and managed habitats will impact on the management of agricultural and environmental settings. Potential applications include crop production and protection, degradation or sequestration of environmental pollutants, extraction of metals from ores, industrial fermentations, and productions of enzymes, diagnostics, and chemicals. Applications of this technology will ultimately include the release of beneficial agents in the environment. If safely deployed, genetically modified bacteria should be able to provide significant benefits in the management of environmental systems and in the development of new environmental control processes. 79 refs., 3 tabs.

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

Refer also to citation(s) 26008, 26009, 26766, 26776, 26795, 26845

26893 (ENEA-RT-SAG--89-03) **Evaluation of committed dose to man due to radioactive contamination of food and fodder.** Cucchi, G. Bologna Univ. (Italy). Oct 1989. 18p. (In Italian). (RT/SAG--89-3). Order Number DE90764344. Available from NTIS (US Sales Only), PC A03/MF A01.

First, the author examines the ways in which radioactive contamination of the air propagates to food and fodder and then reviews the radioisotopes found in ambient samples in Italy, during the Chernobyl accident. The aim is to apply the results he obtains to every other type of radioactive contamination. The author considers the metabolic behaviour of the various nuclides, keeps in mind the meaning of transfer factor and retention function, and takes into account the human individual consumption of the various foods in function of the age classes. He thereby establishes the criteria of evaluation of individual effective and committed doses together with population collective dose.

26894 (PB--90-146473/XAB) **Low-level ionizing radiation and human leukemia: Juvenile and adult dichotomy. Technical report, January 1984-April 1986.** Bowers, E.J.; Zemel, B.S.; Hickey, R.J.; Allen, I.E.; Junker, L.L. Pennsylvania Univ., Philadelphia, PA (USA). Wharton School of Finance and Commerce. Jan 1985. 66p. (UPWS-DS--84). Available from NTIS, PC A04/MF A01.

Human leukemia mortality rates for 43 urban populations (cities) of the United States, 1957-1964, were analyzed against several environmental variables using mean annual rates per 100,000 persons for all ages, and for two age subsets. One subset involves rates for persons <25 years; the other involves rates for persons >25 years. Among environmental variables examined were natural background levels of ionizing radiation (RA); mean atmospheric concentrations of several common air pollutant chemicals, and several socio-economic variables. A statistically significant positive correlation was found between RA level and leukemia mortality rate for those <25 years of age. In contrast, for those >25 years, the correlation was weak and negative. Comparably, the correlation between atmospheric vanadium levels and leukemia mortality rates for those <25 years was significantly negative, while the correlation with rates for those >25 years was significantly positive. Other such contrasts were found, as for atmospheric nickel and for sulfate, and for water hardness. Such results are compatible with findings of others, and support the hypothesis that the etiologies of juvenile and adult-onset leukemias are quite different. Possible foundations for these differences are considered.

26895 (PB--90-859588/XAB) **Antiradiation drugs. March 1972-December 1989 (A Bibliography from the International**

Aerospace Abstracts data base). Report for March 1972-December 1989. . National Technical Information Service, Springfield, VA (USA). Feb 1990. 46p. Available from NTISPC N01/MF N01.

Supersedes PB-82-872771; U.S. sales only.

This bibliography contains citations concerning antiradiation drugs for radiation protection. The biological efficacy and the physiological effects of these drugs are discussed. Radiation protection for spacecraft crews is also discussed. (This updated bibliography contains 90 citations, 28 of which are new entries to the previous edition.)

26896 (PNL-SA-17321) **Biological effects of ELF [extremely-low-frequency] electric and magnetic fields.** Anderson, L.E. Pacific Northwest Lab., Richland, WA (USA). Oct 1989. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. (CONF-8909315-1: US/USSR cooperative agreement on physical factors in the environment, Prague (Czechoslovakia), 24 Sep - 10 oct 1989). Order Number DE90008634. Available from NTIS, PC A02/MF A01 - OSTI.

Studies have been conducted at the Pacific Northwest Laboratory to examine extremely-low-frequency (ELF) electromagnetic fields for possible biological effects in animals. Two areas of investigation are reported here: (1) studies on the nervous system, including behavior and neuroendocrine function, and (2) experiments on cancer development in animals. In behavioral experiments, preliminary data suggest that short term memory may be affected in albino rats exposed to combined ELF and static magnetic fields. Neuroendocrine studies were conducted to demonstrate an apparent stress-related response in rats exposed to 60-Hz electric fields. Finally, using a chemically-induced mammary tumor model, experiments were conducted in which rats, chronically exposed to 60-Hz electric fields, showed an enhancement in the number of tumors per tumor bearing animal.

26897 Evaluation of laser phosphorimetry for the analysis of uranium in biological samples from laboratory animal studies. Gray, D. (Lovelace Inhalation Toxicology Research Institute, PO Box 5890, Albuquerque, NM (US)); Eidsom, A.F. vp. of Proceedings of the thirtieth annual conference on bioassay, analytical and environmental chemistry. . NLO, Inc., Cincinnati, OH (USA) (1985). (CONF-8410197-: 30. annual conference on bioassay, analytical and environmental chemistry, Cincinnati, OH (USA), 10-12 Oct 1984).

Laser phosphorimetry has been used for uranium analyses in a variety of sample matrices, including environmental and human bioassay samples. The Scientrex-UA-3 Uranium Analyzer has been used at ITRI to acquire data on the applicability of laser phosphorimetry to analyses of uranium in the highly concentrated solutions resulting from chemical processing of biological comparisons of results with those obtained from conventional fluorometry. These comparisons have been very favorable for many sample types. Results of these comparisons and an evaluation of the data obtained with the Scintrex unit are presented.

26898 Modeling for scaling to humans: Time to get serious. Thomas, R.G. (Department of Energy, Washington, DC (USA)). *Health Physics (USA)*, : 13-17 (1989).

The subject matter for this 26th Annual Hanford Life Sciences Symposium evolved from the deliberations of a Task Group on Modeling for Scaling to Humans, which was established in January 1986 through the efforts of the Office of Health and Environmental Research of the Department of Energy (OHER/DOE). Several laboratories that utilize animals in radiobiological research sponsored by the OHER/DOE were extensively reviewed in the spring of 1985, and, as a result, OHER recommended establishment of eight task groups designed for selected purposes. The current membership of the Task Group on Modeling for Scaling to Humans is presented. Dr. James A. Mewhinney of the Lovelace Inhalation Toxicology Research Institute has been Chairman since these Task Groups were established. Ms. Judy Mahaffey of Battelle. Pacific Northwest Laboratories served as chairperson for this symposium, and the Task Group membership has served as the Program Committee. The OHER/DOE thanks all of them for their work as members of the Task Group as well as for their arranging such a potentially productive and informative meeting.

26899 Bacterial blight of soybean: Regulation of a pathogen gene determining host cultivar specificity. Huynh, T.V. (Univ. of California, Berkeley (USA)); Dahlbeck, D.; Staskawicz, B.J. *Science (Washington, D.C.) (USA)*, 245(4924): 1374-1377 (22 Sep 1989). DOE Contract FG03-88ER13917.

Soybean cultivars resistant to Pseudomonas syringae pathovar glycinea (Psg), the causal agent of bacterial blight, exhibit a hypersensitive (necrosis) reaction (HR) to infection. Psg strains carrying the avrB gene elicit the HR in soybean cultivars carrying the resistance gene Rpg1. Psg expressing avrB at a high level and capable of eliciting the HR in the absence of de novo bacterial RNA synthesis have been obtained in in vitro culture. Nutritional signals and regions within the Psg hrp gene cluster, an approximately 20-kilobase genomic region also necessary for pathogenicity, control avrB transcription.

5602 Thermal Effects

Refer also to citation(s) 26016

5603 Chemicals Metabolism and Toxicology

Refer also to citation(s) 25388, 25390, 25391, 25429, 26581, 26582, 26583, 26613, 26622, 26649, 26794, 26795, 26797, 26803, 26805, 26843, 26894

26900 (DLR-FB-89-55) **Multispectral classification of overlapping classes with applications to forest damage areas.** Reinartz, P. (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Wessling (Germany, F.R.). Inst. fuer Optoelektronik). Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Koeln (Germany, F.R.); Hannover Univ. (Germany, F.R.). Fakultaet fuer Bauwesen. 1989. 182p. (In German). Order Number DE90767350. Available from NTIS (US Sales Only), PC A09/MF A01.

After a critical investigation of the multispectral classification of remotely sensed data, several proposals are made for an optimization of supervised classifications. First, quantitative separability measures are derived for the analysis of class differences. With these measures, criteria for the optimal selection of channels, training areas and classes can be determined, as well as artificial channels and radiometric correction algorithms can be quantitatively investigated. The developed methods are applied and tested for the classification of tree species and damages in airborne thematic mapper data acquired by the linescanner DAEDALUS ATM 1286. (orig.) With 84 figs., 12 tabs., 156 refs.

26901 (ENEA-RT-PAS-89-04) **Tracheal epithelial injuries due to the inhalation of low concentration sodium combustion products: Scanning electron microscopy of rat issue.** Pagano, P.; Forner, G.; Fagarazzi, G.; Bruni, S. ENEA, Bologna (Italy). Dipt. Ambientale e Salute dell'Uomo. May 1989. 46p. (In Italian). (RT/PAS-89-4). Order Number DE90764336. Available from NTIS (US Sales Only), PC A03/MF A01.

This work was carried out within the framework of the research that the ENEA (Italian Commission for Alternative Energy Sources) laboratory is carrying out on the atmospheric behaviour of aerosols produced in a hypothetical accident involving the cooling system of a energy power plant utilizing sodium as a cooling liquid. This experiment was conducted by exposing Sprague-Dawley rats to a mean concentration of sodium combustion products equal to half the minor concentration used in the previous experiments conducted in this lab, because in those tests tracheal epithelial injuries were always found in all the exposed animals. The morphologic investigation conducted with scanning electron microscopy (SEM) enabled the researchers to follow the morpho-descriptive analysis and to quantify the injuries to correlate the cytotoxic effect with the given dose.

26902 (KFK-PEF-50-Vol.1, pp. 61-65) **Uptake and localization of minerals in ectomycorrhizae of forest trees.** Kottke, I. (Tuebingen Univ. (Germany, F.R.). Inst. fuer Botanik, Spezielle Botanik, Mykologie); Woellmer, H.; Oberwinkler, F. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt

Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

The investigations are carried out to get further knowledge on uptake, storage and possible detoxification of minerals, especially aluminium ions, by ectomycorrhizae of forest trees. (orig./KG).

26903 (KFK-PEF-50-Vol.1, pp. 1-10) **Histological and histochemical investigations on the nutrient dynamics in forest trees with regard to the 'new-type forest-decline'.** Fink, S. (Tuebingen Univ. (Germany, F.R.). Abt. Biochemie der Pflanzen). Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

Within the scope of physiological-anatomical investigations on healthy and damaged needles from spruces, firs, and pines, first of all a structural peculiarity of the needles of the Pinaceae is stressed. The possible role of an active symplastic regulation of the water and mineral budget of a needle through the bundle sheath and its significance with regard to air pollution damages are discussed. Peciuliarities in the wall structure of mesophyll cells are shown and related to possible consequences for apoplastic transport. Additionally, with the aid of fluorescent tracers, the migration of substances through the cuticle of intact needles couid be visualized. (orig./KG).

26904 (KFK-PEF-50-Vol.1, pp. 35-60) **Forest fertilization - possibilities and limitations.** Evers, F.H. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

The nutritional deficiencies and imbalances in damaged spruces can be removed by purposeful fertilization. On fertilized plots as well as in fertilizing trials corresponding results were obtained. Mineral fertilizers are nevertheless not without effect on the soil biology and hydrology. Different kinds of fertilizers and doses therefore must be well adapted to site, stand and soil conditions. Injuries must not be feared. Application of silicate rock is especially recommended, because of less damages to humus and hydrosphere. (orig./KG).

26905 (KFK-PEF-50-Vol.1, pp. 79-92) **Soil animals as sensitive indicators in deciduous and coniferous forests.** Funke, W. (Ulm Univ. (Germany, F.R.). Abt. Oekologie und Morphologie der Tiere); Jans, W.; Kuehner, M.; Lehle, E.; Ratajczak, L.; Schreiber, R.; Stumpp, J.; Vogel, J.; Wanner, M. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

Comparative considerations were carried out on species numbers and abundance of Protozoa and Metazoa (invertebrates) in spruce stands, deciduous forests and in an old orchard. Influences of weather as well as long term-effects of liming and fertilizing soil surface were demonstrated in different animal groups. Testacea: In spruce stands the humification is much lower than in deciduous forests and in the old orchard. Between control and fertilized areas no striking differences were recognized. Ciliata: Species number, dwelling density and dominance structure are highly dependent on the pH-value of soil. Nematoda: In the spruce stand U1 the shares of bacterivorous species are higher in fertilized and humid areas than in the control area. Mycetophagous/root-feeding species are demonstrating the contrary. This refers to a decrease of fungi and/or fine roots. Enchytraeidae: The negative effects of liming and fertilizing soil surface on enchytraeid worms are still immense after five years. (orig./KG).

26906 (KFK-PEF-50-Vol.1, pp. 93-103) **Element fluxes in the ecosystem 'spruce-stand' with special regard to invertebrate animals.** Roth-Holzapfel, M.; Funke, W. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

In the most important representatives of invertebrate-fauna of a spruce-stand nearby Ulm (Swabian Alb) the concentrations of essential and toxic elements have been determined by the mean of ICP-atomic-emissionspectroscopy and flameless atomic absorption spectrometry: Al, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Ni, Pb, Zn. Estimation of 'element-fluxes' in the ecosystem, with special regard to invertebrates and the question, if animals are suited as indicators of heavy metal pollution, have been of special interest. Species of different systematic and trophic groups (Lumbricidae, Enchytraeidae, Diplopoda, Araneae, Collembola, Coleoptera and Diptera of phytophagous, saprophagous and zoophagous trophic levels) have been investigated. Invertebrates accumulate - except of Cd - predominantly physiological active elements (Cu, Zn, K, Mg, Ca). Most elements were accumulated by animals of low trophic level. Because of the high enrichment of Cd in Lumbricidae, Enchytraeidae and Nematocera, these species seem to be suited as indicators of Cd burden of the environment. (orig./KG).

26907 (KFK-PEF-50-Vol.1, pp. 105-115) **Progeny test of Norway spruce stands in the Black Forest (areas of origin 840 08 and 840 09) aiming at: 1. improvement of immission tolerance, 2. conservation of genetic resources of damaged stands in high altitudes ('gene bank').** Franke, A. (Forstliche Versuchs- und Forschungsanstalt Baden-Wuerttemberg, Freiburg im Breisgau (Germany, F.R.). Abt. Botanik und Standortskunde); Konnert, M.; Wurth-Goldammer, T. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

Considering continuous forest damage caused by air pollutants seeds of Norway spruce (Picea abies (L.) Karst.) were harvested in 39 different Black Forest stands in autumn 1987 in order to start a progeny test. New facts about autochthony, vitality, fitness and perhaps immission tolerance of these provenances are expected. In 1988 seed quality was tested and plant production for future field trials could start. The results of immission isozyme analysis are presented and interpreted. (orig./KG).

26908 (KFK-PEF-50-Vol.1, pp. 141-173) **Experimental investigation of forest decline: The use of open-top chambers.** Last, F.T. (Edinburgh Univ. (UK). Dept. of Forestry and Natural Resources). Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (CONF-8903205--: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe

(Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

The article deals with the problems and possibilities of open-top chambers in forest decline research. Three aspects are considered: (a) the nature of evidence, (b) how should forest decline or tree health be characterised and (c) the experimental investigation of forest decline. (KG).

26909 (KFK-PEF–50-Vol.1, pp. 175-185) **Investigations on spruce trees in a diseased forest area with exclusion of gaseous pollutants in open-top chambers.** Seufert, G. (Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Landeskultur und Pflanzenoekologie); Hoyer, V.; Arndt, U. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

At Edelmannshof in the Swabian-Frankonian-Forest a pollutant-exclusion experiment is running since summer 1986. Each four 19 years old, naturally rooting and healthy looking spruce trees are kept in charcoal-filtered air and ambient air with the help of open-top chambers (one tree per chamber). As in the years before we were concentrated on chamber operation, measurement of climatic/edaphic site conditions and pollutant concentration and deposition. After computing all measures from more than two years it can be stated that variants with ambient and charcoal filtered air differ for more than 80% in SO_2-, NO_2- and O_3-concentration. Compared to outside edaphic conditions in the chambers are indentical and climatic conditions differ only slightly. (orig./KG).

26910 (KFK-PEF–50-Vol.1, pp. 187-199) **Ecophysiological measurements on pollutant stressed trees OTC Edelmannshof.** Schweizer, B. (Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Landeskultur und Pflanzenoekologie); Arndt, U. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

At the station Edelmannshof in the Swabian-Frankonian-Forest since July 1988, ecophysiological measurements were carried out on 16 years old, naturally rooting and healthy looking spruce trees, which are growing in open-top chambers with charcoal-filtered and non-filtered air. The main emphasis of our studies were put on the determination of CO_2/H_2O- gasexchange under standardized conditions. From the data of light- and CO_2-saturation-curves, different parameters characterizing the photosynthetic activity were calculated. The results indicate no significant differences between polluted and non polluted trees except spruce trees C (non-filtered air), which showed in July and August a marked reduction of photosynthetic capacity and carboxylation velocity as well as efficiency of light utilization. (orig./KG).

26911 (KFK-PEF–50-Vol.1, pp. 201-213) **Water-, needle- and soil related analyses accompanying research done with open top chambers and an air measuring survey conducted at Edelmannshof/Weizheimer Wald.** Evers, F.H. (Forstliche Versuchs- und Forschungsanstalt Baden-Wuerttemberg, Freiburg im Breisgau (Germany, F.R.)); Seufert, G. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

In open top chambers set up around 15- to 20-year-old spruces - the influence of filtered and surrounding air on deposition and leaching processes in the tree crown were examined. Also, appropriate measure instruments were installed under open air spruces. A four-year lasting research period brought the result that there is considerably less sulphate under spruces affected by filtered air. Together with a raising of the sulfate deposition goes a raising of deposition rates of mangan, calcium, and magnesium which prefer going with sulfat ions. Kalium is different. It shows a strong relation to dissolvable organic chemical figures (DOC). The loss of nutrient elements in the needles is compensated by a quick up-take through the roots. (orig./KG).

26912 (KFK-PEF–50-Vol.1, pp. 215-225) **The effect of charcoal filtered and non-filtered air on the metabolism of spruce trees in a diseased forest area.** Manderscheid, R. (Bundesforschungsanstalt fuer Landwirtschaft, Braunschweig (Germany, F.R.). Inst. fuer Produktions- und Oekotoxikologie); Jaeger, H.J. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

Some biochemical and physiological parameters of twelve 18 years old spruce trees growing in a diseased forest area ('Edelmannshof', a location in the Swabian-Frankonian-Forest) in open-top-chambers with charcoal-filtered and non-filtered air were studied. Between April 1987 and May 1988 the following parameters were measured in young and one year old needles: Protein content, amino acids, glutamate dehydrogenase- and glutamine synthestase activity; glutathione- and ascorbate content, ascorbate peroxidase- and superoxide dismutase activity; total peroxidase activity, buffer capacity and sulfur content (organic and inorganic). In October 1987 the protein content and the glutamate dehydrogenase activity was slightly higher in the unfiltered group and also the concentration of some amino acids like glutamate, aspartate, glutamine and serine. For glutamine synthetase activity a significant difference between the filtered and unfiltered chambers was found. The enzyme activity increased nearly twofold in the young needles of the polluted trees. (orig./KG).

26913 (KFK-PEF–50-Vol.1, pp. 227-234) **Diurnal variation of monoterpene emissions from Picea abies in open-top chambers of the Welzheim Forest.** Bufler, U. (Tuebingen Univ. (Germany, F.R.). Inst. fuer Chemische Pflanzenphysiologie); Juettner, F. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

The concentrations of monoterpenes emitted by 15-year-old Picea abies which had been enclosed in open-top-chambers and gased with charcoal-treated air and untreated forest air, respectively, for three years were determined by mass fragmentography. The one hour mean concentrations of the following components were measured: α-pinene, β-pinene, sabinene, camphene, myrcene, Δ 3-carene, limonene and 1,8-cineole. Pronounced diurnal dynamics of all monoterpene concentrations were observed. At noon and in the afternoon maximum concentrations were observed. During the night the concentrations dropped to a very low level. The differences of the monoterpene concentrations in the two differently gased open-top-chambers were not large enough at the sampling dates to be significant. (orig./KG).

26914 (KFK-PEF–50-Vol.1, pp. 235-245) **Controlled fumigation with O_3 and SO_2 of spruce trees in open top chambers:**

Energy and redox status, and intermediates of carbon partitioning in one- to three-year-old needles. Einig, W. (Tuebingen Univ. (Germany, F.R.). Abt. Biochemie der Pflanzen); Egger, B.; Hampp, R. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

Metabolite pools were determined in lyophilized homogenates of 1- to 3-year-old needles from 13-year-old spruce trees which, in addition to filtered air, had been exposed in open top chambers for 5 years to SO_2 and O_3, singly and in combination. The samples were taken shortly before bud sprouting. The energy (ATP/ADP) and redox status (NAD(P)H/NAD(P)) increased with needle age. This increase was most pronounced in needles from the combination experiment. With regards to the metabolism of carbohydrates, levels of starch, sugars (sucrose, fructose, glucose), sugar phosphates (dihydroxyacetone phosphate, glyceraldehyde 3- phosphate (triose phosphates, TP), fructose 6-phosphate, fructose 2,6- biphosphate: $F_{26}BP$) and of 3-phosphoglyceric acid (PGA) were measured. The amounts of starch, glucose, fructose and TP increased with needle age, while those of sucrose and $F_{26}BP$ decreased. Needles from fumigated trees generally showed somewhat lower starch and sugar levels, and so was fructose 6-phosphate. (orig./KG).

26915 (KFK-PEF--50-Vol.1, pp. 247-257) **Investigations on the thylakoid membrane (P-700 and cytochrome f) and the phosphoenolpyruvate-carboxylase of Norway spruce in open-top-chambers.** Wild, A. (Mainz Univ. (Germany, F.R.). Inst. fuer Allgemeine Botanik); Flammersfeld, U.; Tietz, S. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

The investigations were carried out with needles from healthy looking Norway spruce. Trees of open-top-chambers containing purified or ambient air were compared with trees growing outside the chambers. It was investigated whether P-700-, cytochrome f-, chlorophyll- and soluble protein-content as well as the activities of phosphoenolpyruvate-carboxylase (PEPC) and glutamate-dehydrogenase (GDH) were different in trees growing in the different environments. Trees standing inside chambers since summer 1986 show reactions indicating a response caused by different light-intensities: The cytochrome f-content in the Norway spruce is low compared to the control trees growing outside. The ratio P-700 to cytochrome f and the amount of chlorophyll is lower in the trees outside the chambers. (orig./KG).

26916 (KFK-PEF--50-Vol.1, pp. 259-269) **Changes of plant hormone levels in conifers subjected to immissions.** Frenzel, B. (Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Botanik); Christmann, A. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

The effect of reduced immissions on the phytohormone balance in conifers (ethylene, abscisic acid) is investigated on two sites: 1. The first site was under strong SO_2-impact until autumn 1987. 2. On the second site, spruce trees in open top chambers receiving charcoal-filtered air are compared with trees outside the chambers and trees in chambers receiving ambient air. Until now there are no systematic and significant differences seen in the hormone contents of the differently treated groups of trees. (orig./KG).

26917 (KFK-PEF--50-Vol.1, pp. 271-279) **Effects of precipitation on leaching processes with respect to air quality and nutrient contents.** Boehm, G. (Forstliche Versuchs- und Forschungsanstalt Baden-Wuerttemberg, Freiburg im Breisgau (Germany, F.R.)). Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

The simulation of field-conditions was not possible in tested open-top-chambers which were exposed in the southern part of the Black Forest. The carrying out of a leaching experiment is considered to be a convenient further utilization of the chambers (only chamber comparison). Under filtered air-condition, the leaching of cations out of the needles would be least. At the anions, there is another situation. Whereas the SO_2- and Mn-concentration at filtered and ambient air are almost the same, NH_4 and NO_3 are leached increasingly under ambient air-conditions. The leaching process is not comparable between field and chambers. Specially striking seems, that just the chamber supplied with surrounding air, is showing the greatest leaching differences to the field. (orig./KG).

26918 (KFK-PEF--50-Vol.1, pp. 281-292) **Investigations of damaging effects of ammonium on the metabolism of Scots pine seedlings (Pinus sylvestris L.).** Vollbrecht, P. (Freiburg Univ. (Germany, F.R.). Inst. fuer Biologie 2); Flaig, H.; Kasemir, H. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

Our investigation aims at a causal description of the effect of ammonium (NH_4^+) on the development of Scots pine seedlings. Our results show that exogenously applied NH_4^+ (5-15 mM) is not sufficiently assimilated thus leading to endogenous accumulation of ammonium in the seedlings. Moreover we find a NH_4^+-induced reduction of potassium and a drastic accumulation of starch in cotyledon whorls, and a significant reduction of root growth. (orig./KG).

26919 (KFK-PEF--50-Vol.1, pp. 293-303) **Physiological and biochemical investigations into the yellowing of spruce at higher altitudes. Pt. 2. First results from the PEF research site near Freudenstadt.** Siefermann-Harms, D. (Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Genetik und Toxikologie von Spaltstoffen). Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205--: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

During Summer and Fall 1988 two spruce trees (Picea abies (L.) Karsten) were examined for the chlorophyll (Chl) and carotenoid content of their needles, the Chl-protein-complex patterns of their thylakoids, and for the behavior of their Light-harvesting Chl-a/b-Protein Complex LHC, under acidic conditions: (1) During greening of young needles and during yellowing of older needles, Chl-b, carotene and neoxanthin increased or decreased, respectively, proportionally to Chl-a. Lutein and violaxanthin behaved like the other pigments during greening, but decreased more slowly than the latter during yellowing. (2) The pattern of Chl-protein complexes isolated from thylakoids of yellow needles did not differ significantly

from that of green needles. (3) An acid-stable LHC was isolated from both, green and yellow needles which maintained their actual Chl content. From needles shortly before yellowing, an LHC with lower acid stability was obtained. When yellowing ceased, stable LHCs were isolated again. (orig./KG).

26920 (KFK-PEF–50-Vol.1, pp. 313-323) **Reflectance spectra of leaves and needles as basis for the physiological evaluation of tree damage. Pt. 2. Basic measurements.** Buschmann, C. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Botanisches Inst. und Botanischer Garten); Kocsanyi, L.; Nagel, E.; Rang, S.; Stober, F. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

A new measuring device (VIRAF) has been developed, which makes it possible to determine in vivo spectra of reflectance, absorption and fluorescence emission as well as induction kinetics of fluorescence of leaves and needles. By combining physiological measuring methods with measurements of reflectance spectra a basis is offered for the physiological evaluation of damage to trees. Basic measurements are described which shall systematically clarify the influence of changes of particular factors (intercellular density, chlorophyll concentration, photosynthetic activity and intensity of the chlorophyll fluorescence). It can be shown that under remote sensing conditions the chlorophyll concentration and the photosynthetic activity of the sample influence the reflectance spectrum, since chlorophyll fluorescence is superimposed on the reflectance in the region around 700 nm. In addition, a technique is presented which makes it possible to quantify the colour of a sample from our reflectance and transmission spectra, respectively, according to the norm of the CIE 1931. (orig./KG).

26921 (KFK-PEF–50-Vol.1, pp. 325-340) **Chlorophyll fluorescence signatures of healthy and damaged spruce trees during a period of a year.** Rinderle, U. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Botanisches Inst. 2); Lichtenthaler, H.K. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

The pigment content (chlorophylls, a/b, carotenoids, (a and b)/(x and c)), the net CO_2-assimilation rate (P_N), the transpiration and stomatal conductivity (gH_2O) as well as different parameters of the in vivo chlorophyll fluorescence were measured from August 1987 to December 1988 in the needles of two spruce stands in the Northern Black Forest. The fluorescence parameters measured comprise the Kautsky induction kinetics with Rfd-values as vitality index (at 690 and 735 nm), the stress-adaptation index Ap, the photochemical and non-photochemical quenching coefficients (qQ and qE), the ratio of maximum to ground fluorescence Fm/Fo, the height of the saturation fluorescence peak (g-h) as well as the ratio of the two fluorescence-emission maxima F690/F735. Stress is primarily documented by a lower chlorophyll content per needle area, lower values of the ratio (a and b)/(x and c), decreased Rfd-values, lower height of the saturation fluorescence peak (g-h) as well as increased values of the coefficient qE and the fluorescence ratio F690/F735. (orig./KG).

26922 (KFK-PEF–50-Vol.1, pp. 341-361) **Changes of ground vegetation in damaged stands in the Black Forest with respect to immissions and fertilization.** Buerger, R. (Freiburg Univ. (Germany, F.R.). Inst. fuer Landespflege); Schornick, O.; Steinlin, H. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

The results and conclusions about changes of ground vegetation in stands of the Black Forest are presented. To this end the species composition was examined in areas of varying degrees of decline. Special attention was paid to ecological groups and their indications. These releves were compared laterally as well as with historical data. The observations indicate two primary influences on succession, first, increased levels of light, due to the thinning of the trees' crowns and second, increased levels of nitrogen due to pollution. The second study analyses the reaction of ground vegetation to fertilization in spruce forests of the Northern Black Forest. It has been shown, that even more than 30 years after fertilization there was still a distinct reaction in the case of higher amounts of given fertilizer. More species and a higher cover of abundance was the result in the herb layers. The cover abundance of the moss layers was slightly retrograde. Also differences in vitality of species has been shown. A comparison of both studies for spruce stands gave some references to the effects of pollution, but showed also some problems using ecological groups for indication matters. (orig./KG).

26923 (KFK-PEF–50-Vol.1, pp. 363-371) **The impact of fertilization and site preparation on natural regeneration of declined forest stands in the Black Forest.** Littek, T. (Freiburg Univ. (Germany, F.R.). Waldbau-Institut). Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

In the region of the Black Forest 4 test plots have been established in stands of different degrees of damage in sites of different acidification and nutrient deficiency. The natural regeneration of common spruce, european silver-fir, beech, sycamore maple and european mountainash has been simulated by controlled seeding in spring 1988 on plots with different site preparation and fertilization. Considering the most important ecological parameters the germination rate and development of the seedlings has been analysed during the first growth period. Simultaneously a seeding was realized in a greenhouse under controlled conditions in a reduced number of variations. (orig./KG).

26924 (KFK-PEF–50-Vol.1, pp. 373-384) **Amounts of heavy metals in Norway spruce from differently polluted sites.** Trueby, P. (Freiburg Univ. (Germany, F.R.). Inst. fuer Bodenkunde und Waldernaehrungslehre); Zoettl, H.W. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

The aim of the investigation was to determine lead, cadmium, and zinc uptake of Norway Spruce depending on the content of the soil. Furthermore the amounts of heavy metals taken up by roots and atmospheric deposition respectively should be calculated. Wood totalled more than 80% of these elements, bark and needles each are nearly 10% of biomass. About 3/4 of total Pb and Cd are stored in the stemwood, 1/4 in the bark. The supplies in the needles are lower than 5%. However, the amount of Zn in wood is substantially lower. Only 25% is the calculated airborne Pb, the remainder of 75% must be taken up by the roots. Zn and Cd is completely taken up from the soil. It is supposed that considerable amounts of Zn and Cd are leached, especially from the bark. (orig./KG).

26925 (KFK-PEF–50-Vol.1, pp. 385-395) **Influence of timber felling, geological, and soil data on forest decline in the Schluchsee area.** Saurer, H. (Wuerzburg Univ. (Germany, F.R.). Geographisches Inst.); Gossmann, H.; Behr, F.J.; Baehr, H.P. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

Within the project 'Development of a geographical information system for investigation and monitoring of forest decline' a digital raster dataset - derived from aerial CIR photographs - is combined with data about the amount of timber felling and with geological and soil data. The amount of felling depends on various factors. A very important one is development class. To avoid the influence of different combinations of development classes a regression for 69 forest compartments is calculated. It is shown that damages decrease with an increasing amount of felling. Beyond that, the correlation between forest damage and rock is discussed, the content of magnesium, calcium, potassium and manganese in the soil being used as reference. It proves that forest disease decreases with increasing components of Mg and Ca and with decreasing components of potassium. A correlation between forest decline and the component of manganese of a rock is not stated. The 'Forstliche Standortskarte' (a map of scale 1:10000) contains information about soil, water budget and vegetation. Correlations between these features and the distribution of forest disease have been examined. They turned out to be less significant. (orig./KG).

26926 (KFK-PEF–50-Vol.1, pp. 305-311) **CO_2-gas-exchange and transpiration of open grown Norway spruce during the year in higher elevations of the Southern Black Forest under local air conditions with and without O_3.** Abetz, P. (Freiburg Univ. (Germany, F.R.). Inst. fuer Waldwachstum); Kuenstle, E.; Wolfart, A. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767291. Available from NTIS (US Sales Only), PC A18/MF A01.

The equipment is still in construction for continuous measurements of the gas-exchange (CO_2 and transpiration) at an open grown Norway spruce of 10 m height on the top of a mountain (1230 m asl) near Freiburg, to study the influence of O_3 and the disposition to waterstress, in particular at winter time and inversions of air temperature. There will be measured also the temperature of the needles, of the twigs, of the stem, of the soil, the soil moisture, the stem-diameter changes, the discoloration of the needles and the structure of the chloroplasts. The method and some still unsolved problems are mentioned. (orig./KG).

26927 (KFK-PEF–50-Vol.2, pp. 413-422) **Biochemical investigations on the influence of inhalable particles on lysosomes from alveolar macrophages.** Seidel, A. (Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Genetik und Toxikologie von Spaltstoffen); Wilczek, W.; Paetzold, S.; Schimmelpfeng, J. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

The reactions of alveolar macrophages from rat, cattle, dog, monkey and man to quartz were investigated by biochemical and electronmicroscopic methods. In addition, the human monocytic cell line U-937 was tested. The reactions of the different species were similar from a qualitative and, for some parameters, also from a quantitative point of view. Presence of dipalmitoyl-lecithin reduces the toxicity of the quartz particles in an irreversible manner. After quartz phagocytosis, lysosomes were isolated from bovine alveolar macrophages and incubated. In another series of experiments, lysosomes were isolated from control cells and then incubated in a quartz suspension. In both cases, no evidence for the release of lysosomal enzymes into the incubation medium was obtained. Quartz inhibited the activity of cathepsin B, but not of acid phosphatase or N-acetylglucosaminidase. These and the morphological results are discussed with respect to mechanisms of the cytotoxic and fibrogenic effects of quartz. (orig.).

26928 (KFK-PEF–50-Vol.2, pp. 423-433) **Damage to human lung fibroblasts by ozone.** Mayer, D. (Thoraxklinik Heidelberg-Rohrbach, Heidelberg (Germany, F.R.)); Ebert, W. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

Primary cultures of human lung fibroblasts were exposed to 1 (0.8 ppm) or 5 mg/m^3 (4 ppm) ozone for 20, 4, 2 or 1 h. Two distinct fibroblast cell types could be grown from fresh samples of human lung tissue. After exposure to ozone, cellular mortality differed markedly in both cell types. Ozone triggered an increase in transcription activity as shown by increased cellular RNA contents. In contrast to this, there were only minor changes in cellular ultrastructure. (orig.).

26929 (KFK-PEF–50-Vol.2, pp. 435-449) **Effects of irritant gas induced damage of bronchial epithelium (SO_2, NO_2, ozone, cigarette smoke) on sensitization by inhaled allergens.** Riedel, F. (Marburg Univ. (Germany, F.R.). Zentrum fuer Kinderheilkunde); Rieger, C.H.L. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

This report concerns results of ozone- and tobacco smoke exposure: 5 days of exposure (6 hours per day) with 1.0 ppm O_3, but not with 0.5 ppm O_3, enhance bronchial sensitization compared to an air-exposed control group. The combination of 1.0 ppm SO_2 (not effective on its own) with 0.5 ppm O_3 has the same effect. Exposure with tobacco smoke (mixture of main- and sidestream smoke), leading to serum Cotinine levels of 87 ng/ml in the mean at the end of the 5th exposure day, enhances sensitization to inhaled Ovalbumin as well. During a 5-day exposure with 5 ppm SO_2 groups of 6 animals were treated prophylactically with anti-inflammatory drugs and the influence on the sensitization by inhaled Ovalbumin was studied. Inhalation of Nedocromil-Sodium and high-dose oral Methylprednisolone (8 mg/kg/d) could completely inhibit inhalative sensitization. Indomethacin was only partly effective, whereas no effect was seen on treatment with low-dose steroids and PAF-antagonist WEB 2170 BS. Inflammatory reactions as the leading pathogenetic mechanism of air pollution induced inhalative sensitization is discussed. (orig./MG).

26930 (KFK-PEF–50-Vol.2, pp. 451-462) **Interactions between the inhalative noxe NO_x and the synthesis and secretion of specific surfactant components as markers for lung injury in the rat.** Mueller, B. (Marburg Univ. (Germany, F.R.). Pneumologisches Forschungslabor); Wichert, P. von. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5.

annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

Exposure of lungs with nitrogen dioxide resulted in an increase of total protein and phospholipid in bronchoalveolar lavage fluid. If this reflects also an increase in secretory activity was tested in experiments with isolated type II pneumocytes. In these experiments the basic secretion rate showed no difference between controls and NO_x-exposed rates. Analyses of the stimulated secretion, however, exhibited differences: while control cells could be stimulated to a certain extent the cells from nitrogen-dioxide exposed rates only showed half that extent. Also the Inhibition of the secretion seemed not to be affected by NO_x. Since it was observed additionally that in cells from the exposed lungs there was a higher incorporation of radioactive precursors for the synthesis of phosphatidycholines, experiments were performed to study emzyme activities. As results it was found that there was an increase in enzyme activity for the choline kinase and the CTP-cholin-phosphate cytidylyltansferase. We interprete these findings as regulative reactions to nitrogen dioxide exposure. (orig.).

26931 (KFK-PEF–50-Vol.2, pp. 463-474) **In vitro and in vivo studies of the carcinogenic, toxic and genotoxic activities of the air pollutants SO_2 and NO_x, separately and in combination with carcinogenic polycyclic aromatic hydrocarbons and N-nitrosamines. Pt. 4.** Zeller, W.J. (Deutsches Krebsforschungszentrum, Heidelberg (Germany, F.R.). Inst. fuer Toxikologie und Chemotherapie); Klein, R.G.; Pool, B.L.; Schmezer, P. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

The cytotoxic activity of sulfite (product of SO_2+water) was assessed. In vitro its effects on vitality and energy household were determined in the 3 cell types used in our genotoxicity studies. It was shown: (1) Sulfite toxicity is clearly time- and dose-dependent. (2) By simultaneously determining membrane and cytoskeleton damage, a toxicity parameter is available for pRH in suspension cluture which is as sensitive as determining plating efficiency in tissue culture (FHLC, CO60). (3) The energy system is impaired by sulfite. This was shown by the depletion of intracellular ATP. Differential resistance of cells to sulfite (pRH>FHLC>CO60) is probably due to their relative contents of detoxifying sulfite oxidases. The inhalative application of SO_2 (10 ppm) with and without N-nitrosodimethylamine (NDMA) (1.7 or 3 mg/kg) to SD rats did not result in any measurable toxic effects to the liver, as was determined by measuring vitality and ATP content of explanted pRH. On the other hand, low single doses of <1 mg/kg inhaled NDMA caused a high rate of DNA single strand breaks. Inhaled SO_2 (10 ppm and 50 ppm for 2 weeks) did not cause DNA damage. In contrast to our previous in vitro findings, the genotoxicity of NDMA in liver cells was not measurably affected by simultaneous SO_2 inhalation in an in vivo experimental set up. (orig./MG).

26932 (KFK-PEF–50-Vol.2, pp. 475-484) **Effects of outdoor and indoor air pollution on lung function, bronchial hyperreactivity, mucociliary, risk of pulmonary disease and course of disease.** Eltschka, R. (Freiburg Univ. (Germany, F.R.). Medizinische Universitaetsklinik); Herceg, R.; Matthys, H. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

Our research project has been launched to gain new insights into etiopathogenesis of bronchial hyperreactivity in asthma and chronic bronchitis, by taking into account the effects of indoor and outdoor pollution on the respiratory system. We managed to find participants of 3 defined risk groups (123 hyperreactive patients, 40 with a history of asthma and 30 normal subjects). In patients with hyperreactivity without clinical symptoms of asthma we found a reduced mucociliary clearance (mc). With our long term project we want to investigate whether or not patients with a reduced mc with or without bronchial hyperreactivity undergo a different risk inhaling noxes and to which degree mc will be of prognostic value. (orig.).

26933 (KFK-PEF–50-Vol.2, pp. 485-496) **Air pollution, bronchial hyperreactivity and bronchial pulmonary disorders in children and adults.** Kuehr, J. (Freiburg Univ. (Germany, F.R.). Universitaets-Kinderklinik); Hendel-Kramer, A.; Hader, S.; Urbanek, R.; Karmaus, W.; Steinitz, H.; Stephan, V. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

Bronchial hyperreactivity (BH) is a common feature of bronchial asthma. A sample of 560 school children of 2 different climate areas in the South-West of Germany was analyzed by standardized questionnaire, residential factors, passive smoking and skin prick testing (SPT) with 10 common aeroallergens. BH was investigated by a standardized carbachol inhalation procedure (CIP) in cumulative manner. Pollutants (NO_2, particulate combustion products) in the outdoor air near the childrens residences were measured in the same winter season. The mode of heating and the ventilation manners (VM) in houses were characterized as parameters for indoor climate. In 149 children (26.6%) a BH in the CIP appeared. For multiple logistic regression analysis the best model to explain the existence of BH was fitted. In this final model the relative risk was significantly increased (odds ratio 2.39, 95%-confidence interval 1.19-4.77) by use of stoves within the dwelling burnt with gas, coal or oil. As confounding variable sensitization in SPT and passive smoking appeared significant. Outdoor air pollution and VM were not of significant relative risk. Therefore the indoor climate in residences which are heated by stoves within the rooms burnt with gas, coal or oil must be considered as a potential risk factor for bronchial hyperreactivity in childhood. (orig./MG).

26934 (KFK-PEF–56) **Investigations on conifers by means of scanning electron microscopy and X-ray fluorescence analysis.** Schreiber, H. (Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Physik); Rentschler, I. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Oct 1989. 279p. (In German). Contract PEF 83/008/2. Order Number DE90767416. Available from NTIS (US Sales Only), PC A13/MF A01.

Signals from the detector of a scanning electron microscope contain in their line scans the informations on the surface structure of the objects e.g. of leaves and needles. They can be quantified as spectra of variances presenting the size distribution of structures. Such an objective statistical method has to be applied, for the biological variability will usually drown other influences. The development of sample preparation and analysis made possible numerous measurements of the element contents of needles, surface contamination, and of the bark compartiment (data appendix). We present and interconnect the evolution in time of different elements in different compartiments of a tree. Transfer and leaching phenomena or special deficiencies are reflected by the changes of proportions of pairs of elements like Ca, K or Rb, K rather than by pool sizes of single elements. The bark represents a longtime storage compartiment for Fe, Ti, Cu, and Pb. (orig.) With 100 figs., 89 refs.

26935 (PB–90-143066/XAB) **Evaluation of the immunotoxicity of low-level PCB (polychlorinated biphenyl) exposure in the rat.** Smialowicz, R.J.; Andrews, J.E.; Riddle, M.M.; Rogers, R.R.; Luebke, R.W. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. c 1989. 17p. (EPA–600/J-89/236). Available from NTIS, PC A03/MF A01.

Pub. in Toxicology, Vol. 56, 197-211(1989).

Weanling male Fischer 344 rats were exposed daily by gastric intubation for up to 15 weeks to the polychlorinated biphenyl (PCB) Aroclor 1254 at 0.1, 1, 10, or 25 mg/kg body weight. At 5, 10 and 15 weeks groups of rats were killed and immune functions were evaluated. The immune parameters examined included the following: body and lymphoid organ weights, mitogen stimulated lymphoproliferative (LP) responses, natural killer (NK) cell activity, mixed lymphocyte reaction (MLR), and cytotoxic T lymphocyte (CTL) response. After 10 and 15 weeks of dosing body weights were reduced in rats receiving 25 mg/kg PCB while thymus weights were decreased in rats receiving 10 and 25 mg/kg. NK cell activity was reduced in rats dosed for 15 weeks at 10 and 25 mg/kg. The LP response to phytohemagglutinin was enhanced in rats dosed for 15 weeks at 25 mg/kg PCB. Exposure of rats to PCB did not affect the MLR or CTL responses. Other groups of rats were exposed to cyclophosphamide (CY) and served as positive controls for the immune assays employed. CY induced alterations in all of the immune parameters measured, indicating that this is a sensitive battery of immune function tests which is capable of detecting immune alterations in the rat.

26936 (PB–90-145756/XAB) **Interim procedures for estimating risks associated with exposures to mixtures of chlorinated dibenzo-p-dioxins and-dibenzofurans (CDDs and CDFs) and 1989 update.** Bellin, J.S.; Barnes, D.G. Environmental Protection Agency, Washington, DC (USA). Office of Health and Environmental Assessment. Mar 1989. 98p. (EPA–625/3-89/016). Available from NTIS, PC A05/MF A01.

See also PB–89-125041.

In 1987, the U.S. Environmental Protection Agency (EPA) formally adopted an interim toxicity equivalency factor (TEF) procedure (see PB89 125041), which has been used in addressing a variety of situations of environmental contamination involving CDDs and CDFs. The method, published as Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzofurans (CDDs and CDFs), is republished as Part I of the document. Since the 1987 report was published, the EPA has been active in an international project aimed at adopting a common set of TEFs, the International TEFs/89 (I-TEFs/89), to promote consistency in addressing contamination involving CDDs and CDFs. The 1989 Update to the Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzofurans (CDDs and CDFs) identifies EPA's adoption of the I-TEFs/89 as a revision to the method currently in use. The 1989 Update is Part II of the document.

26937 (PB–90-145954/XAB) **Incorporation and disappearance of oxygen-18 in lung from mice exposed to 1 ppm (18)O_3(1).** Santrock, J.; Hatch, G.E.; Slade, R.; Hayes, J.M. Indiana Univ., Bloomington, IN (USA). Dept. of Chemistry. c 1989. 8p. Available from NTIS, PC A02/MF A01.

Pub. in Toxicology and Applied Pharmacology, Vol. 98, 75-80(1989).

In the study, (18)O(3) was used as a tracer for inhaled ozone in mice. The amount of ozone-derived oxygen (ODO) in the lungs was determined by measuring the amount of oxygen-18 in excess of the natural abundance level which remained covalently bound to organic constituents of lung tissue following exposure to 1 ppm (18)O(3). The rate of disappearance of ODO from the lungs was determined by quantifying the rate of decrease of oxygen-18 in excess of the natural abundance level in lung tissue from mice exposed to 1 ppm (18)O(3) for 45 min. With exposure to 1 ppm (18)O(3), ozone-derived oxygen accumulated in lung tissue at a rate of 4.38 pmoles of ODO/mg/min. ODO had a half-life in lung tissue of approximately 6 h. It was impossible to determine accurately the dose of ozone to tissue from these data. However, it was estimated that in each animal a minimum of 44 pmoles of O(3) reacted with molecular constituents of lung tissue every minute of exposure to 1 ppm O(3).

26938 (PB–90-146028/XAB) **Emerging methodologies for assessment of complex mixtures: Application of bioassays in the Integrated Air Cancer Project.** Lewtas, J. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. c 1989. 14p. (EPA–600/J-89/228). Available from NTIS, PC A03/MF A01.

Pub. in Toxicology and Industrial Health, Vol. 5, No. 5, 839-850(1989).

The assessment of complex mixtures of environmental pollutants requires new interdisciplinary strategies. The integration of bioassay methodologies into these strategies is an important tool which provides direct evidence of the toxicity of a mixture. Short-term genetic bioassays are now widely used in the cancer assessment of complex mixtures. New and emerging interdisciplinary methodologies for the assessment of complex mixtures using bioassays are illustrated by the EPA's Integrated Air Cancer Project. The goals of the project are to identify the major airborne carcinogens and their emission sources, and to improve the methodology and data available for human exposure and risk assessment from airborne carcinogens. The research effort is focused primarily on characterizing the impact of complex mixtures of products of incomplete combustion, including gaseous, semi-volatile, and particle-bound organic species.

26939 (PB–90-146085/XAB) **Polychlorinated biphenyl (Aroclor 1254) induced changes in femur morphometry calcium metabolism and nephrotoxicity.** Andrews, J.E. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. c 1989. 16p. (EPA–600/J-89/222). Available from NTIS, PC A03/MF A01.

Pub. in Toxicology 57, 83-96(1989).

Experiments were performed to investigate the effects of polychlorinated biphenyl (PCB) on calcium metabolism, femur morphometry, and nephrotoxicity. Fischer 344 rats were dosed daily IG for 5, 10, or 15 weeks with 0, 0.1, 1, 10 or 25 mg PCB/kg body weight. After 5, 10 and 15 weeks, liver weight and liver-to-body weight ratio were increased at the two higher dose levels. Overt toxicity was observed at the highest dose level after 10 and 15 weeks as evidenced by significantly smaller body weight. Urinary alkaline phosphatase and lactate dehydrogenase activities were elevated at 5, 10 and 15 weeks of PCB exposure and the kidney-to-body weight ratios were elevated at the 10 and 25 mg/kg dose levels after 10 and 15 weeks of exposure indicating nephrotoxicity. Hypercalcemia was present at the highest dose level after 5 and 10 weeks of exposure but serum calcium concentration was normal at 15 weeks. Serum triglycerides were significantly elevated after 5 weeks of exposure but were significantly decreased after 10 and 15 weeks of PCB exposure. Serum cholesterol was significantly elevated at the two higher dose levels at all three periods. The results demonstrate that PCB exposure effects calcium metabolism and bone morphometry and is nephrotoxic.

26940 (PB–90-146119/XAB) **Carbon monoxide exposure and human visual detection thresholds.** Hudnell, H.K.; Benignus, V.A. North Carolina Univ., Chapel Hill, NC (USA). Dept. of Psychology. c 1989. 11p. Available from NTIS, PC A03/MF A01.

Pub. in Neurotoxicology and Teratology, Vol. 11, 363-371(1989).

In order to test for low level CO exposure effects on vision, a battery of visual tests was administered to male college students. All subjects completed the battery of tests both before and during an exposure period in a double-blind study. Experimental subjects received CO during the exposure period, whereas control subjects received only room air. The battery of visual tests was designed for the assessment of scotopic (dark adapted, rod mediated) vision, photopic (light adapted, cone mediated) vision, the pattern detection process and the motion detection process. Contrast thresholds for the detection of stimulus pattern and for the detection of stimulus motion were measured under both photopic and scotopic viewing conditions, and sensitivity was monitored throughout the course of dark adaptation by measuring luminance thresholds. The results indicated that visual function in healthy, young adult males

was not affected by a COHb level of about 17% which was maintained for over 2 hours.

26941 (PB–90-146143/XAB) **Circulating factors that modify lung-cell DNA synthesis following exposure to inhaled oxidants. 1. Effect of serum and lavage on lung fibroblasts following exposure of adult rats to 1 ppm ozone.** Tanswell, A.K.; Fraher, L.J.; Grose, E.C. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. c 1989. 18p. (EPA–600/J-89/216). Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Toxicology and Environmental Health 27, 239-254(1989).

Adult rats were exposed to 1 ppm (1.96 mg/cu m) ozone or air for 2 weeks. Animals were sacrificed at 3, 5, 7, or 14 days after the onset of exposure and samples of plasma and lung lavage obtained. Heat inactivated plasma, from animals exposed to ozone for 7 or 14 days, significantly increased DNA synthesis by lung fibroblasts compared with plasma from air exposed animals. Fractionation of plasma and lavage samples indicated that the factor responsible had an isoelectric point of 6.45-6.75, and a molecular weight of 32 +/- 2 Kd. This factor has a dose-dependent effect on lung fibroblasts in culture, but no significant effect on cultured pneumocyte DNA synthesis. The factor is detectable within 72 hours of exposure, and may hold some promise as a marker of early oxidant lung injury.

26942 (PB–90-146150/XAB) **Effects of acrylamide on mouse germ-line and somatic cell chromosomes.** Backer, L.C.; Dearfield, K.L.; Erexson, G.L.; Campbell, J.A.; Westbrook-Collins, B. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. c 1989. 10p. (EPA–600/J-89/215). Available from NTIS, PC A02/MF A01.

Pub. in Environmental and Molecular Mutagenesis, Vol. 13, 218-226(1989).

The industrial chemical acrylamide is suspected to be an agent which induces potentially heritable genetic damage. While several studies in rodents have indicated that this substance can damage spermiogenic cells resulting in dominant lethals and heritable translocations, cytogenetic assessments of pre-meiotic and meiotic cells after exposure have produced equivocal results.

26943 (PB–90-146259/XAB) **Effect of intrauterine PCB (polychlorinated biphenyls) exposure on visual recognition memory.** Jacobson, S.W.; Fein, G.G.; Jacobson, J.L.; Schwartz, P.M.; Dowler, J.K. Wayne State Univ., Detroit, MI (USA). c 1985. 10p. Available from NTIS, PC A02/MF A01.

Pub. in Child Development 56, 853-860(1985).

Adverse neonatal outcomes have been associated with intrauterine exposure to polychlorinated biphenyls (PCBs). In a follow-up study of exposed and nonexposed infants, 123 infants tested at birth were administered Fagan's test of visual recognition memory at 7 months. Two measures of prenatal PCB exposure, cord serum PCB level and maternal report of contaminated fish consumption, predicted less preference for a novel stimulus. Preference for novelty decreased in a dose-dependent fashion with increasing levels of prenatal PCB exposure. Postnatal exposure from nursing was not related to visual recognition memory. The relation between prenatal exposure and visual recognition was not mediated by the neonatal deficits, suggesting that intrauterine PCB exposure may have a delayed effect on central nervous system functioning.

26944 (PB–90-146309/XAB) **Summary of the EPA (Environmental Protection Agency) workshop on carcinogenesis bioassay via the dermal route. Final technical report.** Dynamac Corp., Rockville, MD (USA). 29 Apr 1987. 10p. Available from NTIS, PC A02/MF A01.

Traditionally, the oral route has been the most common route of administration in bioassays which tested the potential carcinogenicity of chemicals. Regulatory agencies, however, prefer to have test chemicals applied by the same route as expected human exposure, whenever possible. Since human exposure to industrial chemicals is frequently via the dermal route, this has become a route of choice for animal testing of certain chemicals. However, protocol design for dermal bioassays presents many unique problems which must be addressed before guidelines for bioassays by the dermal route can be formulated. Furthermore, it may be feasible to develop a limited dermal protocol to screen certain classes of chemicals such as acrylates/methacrylates. Recognizing the need for this workshop, it was designed in two distinct parts; to address the problems inherent in the development of a generic protocol for dermal bioassays and, a specific limited dermal bioassay protocol for acrylates/methacrylates.

26945 (PB–90-146523/XAB) **Chlorinated dibenzo-p-dioxin and dibenzofuran residue levels in food. Final report.** Stanley, J.S.; Bauer, K.M. Midwest Research Inst., Kansas City, MO (USA). 26 Oct 1989. 205p. (MRI–8922-A). Available from NTIS, PC A10/MF A02.

The chemical analysis of selected foods was conducted to provide an estimate of the residue levels of PCDDs and PCDFs. The foodstuffs included saltwater fish, freshwater fish, beef, chicken, pork, bovine milk, and eggs. The foodstuffs were collected from San Francisco and Los Angeles. Emphasis was placed on the collection of foodstuffs of California origin. Individual foods collected from multiple sites within San Francisco and Los Angeles were composited for analysis of the residue levels. Detectable levels of PCDDs and PCDFs were identified in all but the egg samples that were analyzed. Overall, the freshwater fish composites were found to have the highest incidence of detectable levels. The order of highest to lowest incidence of detection follows: freshwater fish > saltwater fish > pork and chicken > beef and milk > eggs. All data were generated from a sample size of approximately 10 g of extractable fatty materials. All data are presented to reflect lipid or fat concentrations such that extrapolation with other data bases can be achieved.

26946 (PB–90-147638/XAB) **Chronic effects of 2,2'-dichlorobiphenyl on reproduction, mortality, growth, and respiration of daphnia pulicaria.** Bridgham, S.D. Minnesota Univ., Minneapolis, MN (USA). Dept. of Ecology and Behavioral Biology. c 1988. 11p. Available from NTIS, PC A03/MF A01.

Pub. in Archives of Environmental Contamination and Toxicology, Vol. 17, 731-740(1988).

Previous studies have shown toxic effects of polychlorinated biphenyls (PCBs) on aquatic life only in the micro g/L range, well above normal ambient concentrations. Daphnia pulicaria was isolated from Lake Erie and exposed to 50 ng/L to 10 micro g/L of 2,2'-dichlorobiphenyl (DCB) in lifetable and physiological studies. Reproduction, mortality, growth, and respiration were measured for periods up to the entire lifespan of the animal with and without the use of an organic surfactant. Significant mortality and inhibition of reproduction were found at levels as low as 50-100 ng/L in lifetable studies, and no safe level could be determined. A unique, yet repeatable, dose-response curve occurred in lifetables with maximum inhibition at low to intermediate concentrations. Inhibition at the highest level tested, 10 micro g/L, occurred only after continuous exposure for three generations. Increasing concentrations of CBD stimulated growth, while respiration experiments yielded variable results.

26947 (PB–90-147695/XAB) **Development of in vivo genotoxicity tests in estuarine fish and their application to aquatic toxicology.** Means, J.C.; Daniels, C.B.; Baksi, S.M. Louisiana State Univ., Baton Rouge, LA (USA). Inst. for Environmental Studies. 1988. 7p. Available from NTIS, PC A02/MF A01.

Pub. in Marine Environmental Research, Vol. 24, 327-331(1988).

Genotoxicity assays were developed in embryonic stages of two species of fish, striped bass (Morone saxitilis) and sheepshead minnow (Cyprinodon variegatus), and in the adults of Fundulus heteroclitus using metaphase chromosome aberrations as the endpoint. Dose-dependent responses were obtained with several chemical mutagens, including 9-aminoacridine, ethylmethane sulphonate, cyclophosphamide and n-methyl-n-nitro-n-nitroguanidine, added to estuarine water at doses spanning several orders of magnitude in compound concentration. Exposures ranged from one to four days; however, two-day exposure time was found to be optimal in eggs and larvae. Tissues from the gills, kidney and intestinal tract of adult Fundulus were found to be responsive to mutagen exposure; however, the intestine gave the best responses. The results of these experiments suggest that

these assays are sufficiently sensitive to be used in the field as well as in laboratory tests.

26948 (PB–90-147703/XAB) **Proposed biological testing methods for the United States incineration-at-sea research program.** Strobel, C.J.; Gentile, J.H.; Schimmel, S.C.; Carr, R.S.; Williams, J.W. Environmental Protection Agency, Newport, OR (USA). Environmental Research Lab. c 1988. 8p. (ERNL–904). Available from NTIS, PC A02/MF A01.

Pub. in Marine Pollution Bulletin, Vol. 19, No. 11/B, 605-610(1988).

As part of the United States Environmental Protection Agency's Incineration-at-Sea research program, a suite of toxicity tests has been selected for assessing the toxicity of incinerator emissions generated during the combustion of chlorinated wastes. The test organisms for the five short-term chronic tests are the inland silverside, Menidia beryllina, the myside Mysidopsis bahia, the red macroalga Champia parvula, the polychaete Dinophilus gyrociliatus, and gametes from the sea urchin Arbacia punctulata. The durations of individual tests range from 2 hours to 7 days. The endpoints include survival, growth and reproductive effects. The results have demonstrated that the proposed methodologies can be used to test the toxicity of gaseous emissions, and that there appears to be no significant toxicity associated with the combustion products of a carrier fuel oil.

26949 (PB–90-147711/XAB) **32P-adduct assay: Comparative recoveries of structurally diverse DNA adducts in the various enhancement procedures.** Gupta, R.C.; Earley, K. Baylor Coll. of Medicine, Houston, TX (USA). Dept. of Pharmacology. c 1988. 9p. Available from NTIS, PC A02/MF A01.

Pub. in Carcinogenesis, Vol. 9, No. 9, 1687-1693(1988).

A (32)P-adduct assay for the measurement of low levels (1 adduct per 10(sup 7) nucleotides) of binding of carcinogens to DNA has been reported previously. In this procedure, DNA is enzymatically hydrolyzed to 3'-monophosphates of normal nucleosides and adducts, which are 5'-(32)P-labeled by T4 polynucleotide kinase and (lambda(32)P)ATP. Labeled adducts are resolved by TLC. Enrichment of adducts by extraction in 1-butanol or digestion with nuclease P1 prior to (32)P-labeling, however, increased the sensitivity of detection for many adducts to a level of 1 per 10(sup 9-10) nucleotides, although adduct recovery particularly in the latter assay depended on the chemical nature of adducts. The observation that chemical structure of an adduct may be detrimental in its recovery in the enzyme- and extraction-mediated enrichment procedures may serve as a probe in the structural characterization of adducts of unknown carcinogens.

26950 (PB–90-147786/XAB) **Natural environment surpasses polluted environment in inducing DNA damage in fish.** Kurelec, B.; Garg, A.; Krca, S.; Chacko, M.; Gupta, R.C. Institut Rudjer Boskovic, Zagreb (Yugoslavia). c 1989. 6p. Available from NTIS, PC A02/MF A01.

Pub. in Carcinogenesis, Vol. 10, No. 7, 1337-1339(1989).

Measurement of specific DNA adduct concentrations in target tissues of organisms may provide a key biologic end-point of exposure to environmental carcinogens. Using a general and highly sensitive assay with ^{32}P-postlabeling, it was found that natural populations of freshwater fish species chub, barbel, bream and carp, as well as a marine fish mugil, revealed the presence of four to nine qualitatively similar adducts irrespective of whether they were caught from unpolluted or polluted waters. No statistically significant differences were observed between the adduct levels of fish from the unpolluted waters and those of fish from the polluted waters. A dominant feature of the fish DNA adducts was a species specificity. The finding that a vast majority of DNA modifications in fish are caused by natural factors rather than man-made chemicals offers a basis for a more realistic view in assessing the genotoxic risks in any aquatic environment.

26951 (PB–90-148289/XAB) **Determination of body burdens for polychlorinated dibenzo-'p'-dioxins (PCDDS) and polychlorinated dibenzofurans (PCDFS) in california residents. Final report.** Stanley, J.S.; Bauer, K.M.; Turman, K.; Boggess, K.; Cramer, P. Midwest Research Inst., Kansas City, MO (USA). 26 Oct 1989. 251p. Available from NTIS, PC A12/MF A02.

Determination of body burden levels of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDDs and PCDFs) in residents of California was conducted based on a stratified survey design. Stratification factors included two geographical locations (San Francisco and Los Angeles), three age groups (12 to 34, 35 to 49, and 50 plus years), and sex. A total of 57 adipose tissue specimens were collected across the 12 specific strata. Analysis for the specific 2,3,7,8-substituted isomers was achieved based on high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS). Detectable levels of PCDDs and PCDFs were measured in all samples with isomer patterns consistent with findings in other studies conducted within the United States, Canada, and Europe. A questionnaire focused on the lifestyles of participants in the program was conducted to determine residual and occupational information and possible exposure routes to PCDDs and PCDFs. The data base provides a reference for comparison in future human monitoring programs.

26952 (PB–90-149832/XAB) **Trace-metal interactions in lead-exposed children. Final report for 1 March 1983-29 February 1984.** Chisolm, J.J.; Thomas, D.J. John F. Kennedy Inst., Baltimore, MD (USA). Sep 1989. 96p. Available from NTIS, PC A05/MF A01.

The project consisted of five separate but interrelated studies. Study A, Dose-Effect Relationship between Blood Lead (PbB) and Erythrocytic Porphobilinogen Synthase (PBGS) Activity in Peripheral Blood, was conducted on 91 children to define more precisely the blood lead threshold for the earliest evidence of inhibition of PBGS activity by lead. Study B, Decorporation of Lead, Zinc, Copper, and Cadmium during Calcium Disodium Ethylenediaminetetraacetate (CaNa2EDTA) Treatment of Lead-Poisoned Children, was conducted in 20 children to determine the pattern of urinary loss of these metals under the influence of CaNa2EDTA. Study C, Zinc Supplementation during CaNa2EDTA Therapy: Dose Run-Up Study, was initiated to determine whether oral supplements of zinc, along with small amounts of copper, could minimize the dramatic decrease in plasma zinc that occurs with CaNa2EDTA therapy, without influencing the drug's effectiveness in reducing blood lead concentrations. Study D, D-Penicillamine (PCA) in Chronic Lead Intoxication, was conducted in 30 children to evaluate the effect of the drug on Pb, Zn, and Cu in blood and urine during long-term administration. Study E included several small ancillary studies carried out to identify biological markers of the effect of CaNa2EDTA on renal function.

26953 (PB–90-151770/XAB) **Exposure to chemical additives from polyvinyl chloride polymer extrusion processing.** Lamb, C.S. Southwest Research Inst., San Antonio, TX (USA). Dec 1989. 120p. Available from NTIS, PC A06/MF A01.

The report presents a model to predict worker inhalation exposure due to off-gassing of additives during polyvinyl chloride (PVC) extrusion processing. Data on off-gassing of additives were reviewed in the literature, the off-gassing at normal PVC processing temperatures was studied in the laboratory, process variables were estimated from an equipment manufacturer survey, and worker-activities and possible exposure sources were observed in an industrial survey. The purpose of the study was to develop a theoretical model to predict worker inhalation exposure to additives used during PVC extrusion processing. A model to estimate the generation rate of the additive from the polymer extrudate was derived from the mass transport equations governing diffusion. The mass flow rate, initial additive volatile weight fraction, off-gassing time, diffusivity, and slab thickness are required to determine the generation rate from the model.

26954 (PB–90-162058/XAB) **Toxicological Profile for Cyanide. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). Dec 1989. 119p. Available from NTIS, PC A06/MF A01.

The ATSDR Toxicological Profile for Cyanide is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substances's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins

with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort.

26955 The effect of dose, dose rate, route of administration, and species on tissue and blood levels of benzene metabolites. Henderson, R.F. (Lovelace Biomedical and Environmental Research Institute, Albuquerque, NM (USA)); Sabourin, P.J.; Bechtold, W.E.; Griffith, W.C.; Medinsky, M.A.; Birnbaum, L.S.; Lucier, G.W. *Environmental Health Perspectives (USA),* 82: 9-17 (Jul 1989). DOE Contract AC04-76EV01013.

Studies were completed in F344/N rats and B6C3F$_1$ mice to determine the effect of dose, dose rate, route of administration, and rodent species on formation of total and individual benzene metabolites. Oral doses of 50 mg/kg or higher saturated the capacity for benzene metabolism in both rats and mice, resulting in an increased proportion of the administered dose being exhaled as benzene. The saturating air concentration for benzene metabolism during 6-hr exposures was between 130 and 900 ppm. At the highest exposure concentration, rats exhaled approximately half of the internal dose retained at the end of the 6-hr exposure as benzene; mice exhaled only 15% as benzene. Mice were able to convert more of the inhaled benzene to metabolites than were rats. In addition, mice metabolized more of the benzene by pathways leading to the putative toxic metabolites, benzoquinone and muconaldehyde, than did rats. In both rats and mice, the effect of increasing dose, administered orally or by inhalation, was to increase the proportion of the total metabolites that were the products of detoxification pathways relative to the products of pathways leading to putative toxic metabolites. This indicates low-affinity, high-capacity pathways for detoxification and high-affinity, low-capacity pathways leading to putative toxic metabolites. If the results of rodent studied performed at high doses were used to assess the health risk at low-dose exposures to benzene, the toxicity of benzene would be underestimated.

26956 Peroxidase-dependent metabolism of benzene's phenolic metabolites and its potential role in benzene toxicity and carcinogenicity. Smith, M.T. (Univ. of California, Berkeley (USA)); Yager, J.W.; Steinmetz, K.L.; Eastmond, D.A. *Environmental Health Perspectives (USA),* 82: 23-29 (Jul 1989).

The metabolism of two of benzene's phenolic metabolites, phenol and hydroquinone, by peroxidase enzymes has been studied in detail. Studies employing horseradish peroxidase and human myeloperoxidase have shown that in the presence of hydrogen peroxide phenol is converted to 4,4′-diphenoquinone and other covalent binding metabolites, whereas hydroquinone is converted solely to 1,4-benzoquinone. Surprisingly, phenol stimulates the latter conversion rather than inhibiting it, an effect that may play a role in the in vivo myelotoxicity of benzene. Indeed, repeated coadministration of phenol and hydroquinone to B6C3F$_1$ mice results in a dramatic and significant decrease in bone marrow cellularity similar to that observed following benzene exposure. A mechanism of benzene-induced myelotoxicity is therefore proposed in which the accumulation and interaction of phenol and hydroquinone in the bone marrow and the peroxidase-dependent formation of 1,4-benzoquinone are important components. This mechanism may also be responsible, at least in part, for benzene's genotxic effects as 1,4-benzoquinone has been shown to damage DNA and is shown here to induce multiple micronuclei in human lymphocytes. Secondary activation of benzene's phenol metabolites in the bone marrow may therefore play an important role in benzene's myelotoxic and carcinogenic effects.

26957 Differences in the pathways for metabolism of benzene in rats and mice simulated by a physiological model. Medinsky, M.A. (Lovelace Biomedical and Environmental Research Institute, Albuquerque, NM (USA)); Sabourin, P.J.; Henderson, R.F.; Lucier, G.; Birnbaum, L.S. *Environmental Health Perspectives (USA),* 82: 43-49 (Jul 1989). DOE Contract AC04-76EV01013.

Studies conducted by the National Toxicology Program on the chronic toxicity of benzene indicated that B6C3F$_1$ mice were more sensitive to the carcinogenic effects of benzene than were F344 rats. A physiological model was developed to describe the uptake and metabolism of benzene in rats and mice. The objective was to determine if differences in toxic effects could be explained by differences in pathways for benzene metabolism or by differences in total uptake of benzene. Compartments incorporated into the model included liver, fat, a poorly perfused tissue group, a richly perfused tissue group, an alveolar or lung compartment and blood. Metabolism of benzene was assumed to take place only in the liver and to proceed by four major competing pathways. These included formation of hydroquinone conjugates (HQC), formation of phenyl conjugates (PHC), ring-breakage and formation of muconic acid (MUC), and conjugation with glutathione with subsequent mercapturic acid (PMA) formation. Model simulations confirmed that during and after 6-hr inhalation exposures mice metabolized more benzene on a μmole per kilogram body weight basis than did rats. After oral exposure, rats metabolized more benzene than mice at doses above 50 mg/kg because of the more rapid absorption and exhalation of benzene by mice. Increased metabolism of benzene through the HQC and MUC pathways in mice is consistent with the observed susceptibility of this species to benzene toxicity.

26958 Effect of exposure route, regimen, and duration on benzene-induced genotoxic and cytotoxic bone marrow damage in mice. Rice, R.R. (Brookhaven National Laboratory, Upton, NY (USA)); Luke, C.A.; Drew, R.T. *Environmental Health Perspectives (USA),* 82: 65-74 (Jul 1989). DOE Contract AC02-76CH00016.

Mice were exposed to benzene for 13 to 14 weeks by inhalation for either 3 or 5 consecutive days per week or by gavage for 5 consecutive days per week. A weekly evaluation of peripheral blood smears for micronucleated (MN) erythrocyte frequencies and for the percentage of polychromatic erythrocytes (PCE) indicated that the induction of MN-PCE by benzene depended on the sex and strain of mice and on the route of exposure, but not on the inhalation regimen or on the exposure duration. The frequency of MN normochromatic erythrocytes (NCE) not only depended on the sex and strain of mice and on the route of exposure, but directly depended on the inhalation regimen and on the exposure duration. Similarly, the extent of erythropoietic depression in benzene-exposed mice was dependent on sex, mouse strain, exposure duration, and route. However, in contrast to the MN-NCE data, the 3 day/week exposure regimen induced a more persistent depression in erythropoiesis than the 5 day/week exposure regimen. Exposure to benzene also induced in mice a significant depression in packed cell volume (PCV) and bone marrow cellularity, the magnitude of which depended on the sex and strain of mice and on the regimen and route of exposure.

26959 Hematotoxicity and carcinogenicity of inhaled benzene. Cronkite, E.P. (Brookhaven National Laboratory, Upton, NY (USA)); Bullis, J.E.; Drew, R.T.; Inoue, Tohru; Hirabayashi, Yoko. *Environmental Health Perspectives (USA),* 82: 97-108 (Jul 1989).

CBA/Ca male mice have been exposed to benzene in air at 10, 25, 100, 300, 400, and 3,000 ppm for variable intervals 6 hr/day, 5 days/week for up to 16 weeks. Two weeks of inhaling 10 ppm produced no hematologic effects; 25 ppm induced a significant lymphopenia. Inhalation of 100, 300, and 400 ppm produced dose-dependent decreases in blood lymphocytes, bone marrow cellularity, marrow content of spleen colony-forming units (CFU-S) and an increased fraction of CFU-S in DNA synthesis. Exposure of mice to 300 ppm for 2, 4, 8, and 16 weeks produced severe lymphopenia and decrease in marrow CFU-S. Recovery was rapid and complete after 2 and 4 weeks of exposure. After 8 and 16 weeks of exposure, recovery of lymphocytes was complete within 8 weeks. It took 16 weeks for the CFU-S to recover to that of the age-matched controls after 8 weeks of exposure and 25 weeks to recover to age-matched after 16 weeks of exposure. Inhalation of 3,000 ppm for 8 days was less damaging than inhalation of 300 ppm for 80 days (same integral amount of benzene inhaled). The inhalation of 3,000 ppm has not increased the incidence of leukemia or shortened its latency for development. Inhalation of

300 ppm 6 hr/day for 16 weeks significantly increases the incidence of myelogenous neoplasms in male CBA/Ca mice. Inhalation of 100 ppm for same interval does not influence incidence of myelogenous neoplasms but does increase incidence of solid neoplasms particularly in female CBA/Ca mice. Benzene is a potent carcinogen in CBA/Ca mice.

26960 Multistrain experiments for screening toxic substances. Felton, R.P. (National Center for Toxicological Research, Jefferson, AR (USA)); Gaylor, D.W. *Journal of Toxicology and Environmental Health (USA)*, 26(4): 399 (1989).

The advantages of using homogeneous experimental groups (inbred animal strains) and of using multiple groups within an experiment, based on the power of the Mantel-Haenszel test, were investigated. A simulation experiment was performed to empirically calculate the power of a one-sided Mantel-Haenszel test for multistrain experiments. In each case, the power of the multistrain experiment was compared to the (empirical) expected value, over strains, of the power where each strain is tested individually. In the simulation, use of subgroups, each having different response rates, resulted in an increase in power where a chemical exposure caused an average increase of effects in 10% or more of the animals across strains.

5604 Other Environmental Pollutant Effects

26961 (AD-A–216153/7/XAB) **ELF (extremely low frequency) communications system-ecological monitoring program: Summary of 1988 progress. Technical report, 1 January-31 December 1988.** Zapotosky, J.E. IIT Research Inst., Chicago, IL (USA). Nov 1989. 100p. (IITRI-E–06620-1). Available from NTIS, PC A05/MF A01.

A long-term Ecological Monitoring Program is being conducted to monitor for possible effects from the operation of the U.S. Navy's ELF Communications System to resident biota and their ecological relationships. Monitoring studies were selected through a peer reviewed, competitive bidding process in mid-1982, and work on most studies began in late summer of that year. Preliminary activities of the Program consisted of site selection, characterization of critical study aspects, and validation of assumptions made in original proposal. Subsequently, increasing emphasis has been placed on the collection of preoperational and operational data bases at the Michigan and Wisconsin Transmitting Facilities. The data bases are being used to make proposed spatial and/or temporal comparisons of biological and ecological variables. This report summarizes the progress of the Ecological Monitoring Program during 1988.

26962 (ENEA-RT-DISP–88-06) **Non Ionizing radiations: Sources, application fields, problematics, normatives.** Raganella, L. ENEA, Rome (Italy). Direzione Sicurezza Nucleare e Protezione Sanitaria. Dec 1988. 90p. (In Italian). (RT/DISP–88-6). Order Number DE90764316. Available from NTIS (US Sales Only), PC A05/MF A01.

The purpose of this paper is briefly to review radiation sources, in work and life places, and national standards, proposed or enforced in different countries, with particular reference to ELF, RF and MW electromagnetic fields. It is aimed to give help to qualitative valutation on the work we can carry out for the development of an effective health protection of workers and general public.

26963 (PB–90-147802/XAB) **Microwave irradiation for rapid killing and fixing of plant tissue.** Walsh, G.E.; Bohannon, P.M.; Wessinger-Duvall, P.B. Environmental Protection Agency, Gulf Breeze, FL (USA). Environmental Research Lab. 1989. 5p. (EPA–600/J-89/204). Available from NTIS, PC A01/MF A01.

Pub. in Canadian Jnl. of Botany, Vol. 67, No. 4, 1272-1274(1989).

Irradiation by microwaves allows for rapid killing and fixing of plant tissue, with excellent cellular integrity for histological examination. One or two exposures to microwaves for three seconds in formalin/acetic acid/alcohol gave good preservation of nuclei, chloroplasts, and other plant structures. The microwave method offers a considerable saving of time over traditional methods for killing and fixing plant tissue.

26964 (PB–90-157413/XAB) **Noise test report: Handheld pneumatic rotary drill. Report of Investigations/1989.** Stein, R.R.; Aljoe, W.W. Bureau of Mines, Pittsburgh, PA (USA). Dec 1988. 19p. (BUMINES-RI–9269). Available from NTIS, PC A03/MF A01.

Library of Congress catalog card No. 89-600040.

Using an automated drill test fixture, the U.S. Bureau of Mines measured the sound power levels produced by a small, pneumatic, rotary roof drill. A series of tests was conducted to determine the relative effectiveness of several drill muffling schemes and the relationship between drill soundpower and pneumatic power supplied to the drill. The influence of rotation rate (i.e., airflow), and feed thrust on the penetration rate of the drill was also noted.

26965 (PB–90-859273/XAB) **Industrial noise control: Architectural and environmental aspects. January 1977-January 1990 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1977-January 1990.** . National Technical Information Service, Springfield, VA (USA). Feb 1990. 123p. Available from NTISPC N01/MF N01.

Supersedes PB–89-851208.

This bibliography contains citations concerning architectural and engineering acoustics associated with noise control in industrial environments. Important sources of industrial noise and the level of exposure by workers to noise are examined. Methods for active attenuation of noise, that is, the cancelling of a noise by the addition of further noise, are examined. Both absorptive and non-absorptive noise control methods are presented. (This updated bibliography contains 266 citations, 23 of which are new entries to the previous edition.)

26966 (SIS–1989:6) **Low frequency electric and magnetic fields - effect on fertility and fetal development: A litterature survey 1982 - 1989.** Thommesen, G. Statens Inst. for Straalehygiene, Oslo (Norway). 1989. 69p. (In Norwegian). Order Number DE90623061. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The epidemiological as well as the experimental data are still inconclusive. Inconsistencies within and between research reports make it impossible to state whether, or under what circumstances, low frequency fields may be harmful to reproduction by reducing fertility or by causing fetal malformations or death. The data indicate, however, that a certain care should be exercised in the case of NMR diagnostic imaging, industrial magnetic field exposure, and paramedical pulsed magnetic field therapy on women who might be expected to be in the first trimester of pregnancy, particularly in the unindentified initial phase. Work in connection with visual display units, living in the neighbourhood of overhead high-voltage powerlines, or other every-day sources of exposure to low frequency fields seem, however, to be an insignificant or non-existent threat to an unborn life. 147 refs.

57 HEALTH AND SAFETY

Refer also to citation(s) 26844, 26962

58 GEOSCIENCES

Refer also to citation(s) 25395, 25396, 25397, 25399, 25400, 25402, 25458, 25459, 25564, 25572, 25574, 25583, 25588, 25589, 25678, 26272, 26551, 26558, 26559, 26777

26967 (DOE/ER/13182–T1, pp. 1-7) **U.S. Atlantic continental margin: A typical Atlantic-type or passive continental margin.** Grow, J.A. (Geological Survey, Denver, CO (USA)); Sheridan, R.E. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The conceptual revolutions of sea-floor spreading and plate tectonics between 1961 and 1968 lead quickly to new models for

continental margin evolution starting with an initial rifting phase. The separation of Africa and North America in the post-Triassic to form the central North Atlantic Ocean and its adjacent rifted continental margins was soon considered the type example of this tectonic process. During the last two decades, the collection of marine multi-channel seismic reflection data and the completion of deep drill holes for both scientific and commercial exploration have greatly increased our understanding of the U.S. Atlantic Continental Margin and passive, or Atlantic-type, continental margins in general. This chapter provides a brief introduction to Atlantic Continental Margin research and it outlines the topics addressed in the volume. It also presents a simplified tectonic map and one representative crustal cross-section through Baltimore Canyon Trough in order to point out the major features of Atlantic-type margins.

26968 (DOE/ER/13182–T1, pp. 9-18) **Marine physiography of the U.S. Atlantic margin.** Shor, A.N. (Columbia Univ., Palisades, NY (USA)); McClennen, C.E. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

This chapter presents a literature review of the marine physiography of the U.S. Atlantic shelf, slope, and rise. Recent research on margin geomorphology has emphasized origin and process responsible for the evolution of physiographic features. The development of swath imaging technology and improved navigation and sampling equipment has inspired new views of these incompletely explored regions. While most of the large features of the shelf and slope have been mapped, many smaller-scale features have yet to be mapped or even discovered. Morphologic characterization of many of the larger canyons remain to be investigated and without understanding of the details of canyon morphology, we remain uncertain about the relative influence of proposed canyon-cutting processes. The decreasing resolution of physiography with increasing depth reflects the amount of research effort expended and the increasing difficulty of working at greater depths. Additionally, studies of shelf physiography will be required to resolve the few, albeit important, existing debates and explain any yet-to-be-discovered detailed features. Considerable exploration and detailed mapping and interpretation is in progress for the slope and rise regions and we can anticipate that the next decade of research will produce new views on margin growth processes as well as refinements of existing ideas.

26969 (DOE/ER/13182–T1, pp. 19-55) **U.S. Atlantic continental margin: Structural and tectonic framework.** Klitgord, K.D. (Geological Survey, Woods Hole, MA (USA)); Hutchinson, D.R.; Schouten, H. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

A considerable volume of information now exists from which inferences can be made on the crustal structure of the U.S. Atlantic margin. Summaries of structural studies, as they apply to individual segments of the margin, can be found in subsequent chapters. In this chapter, the authors examine the geophysical framework, general structural framework, deep crustal framework, and plate-tectonic frame work of the Atlantic margin. They outline the important structural elements and geophysical lineaments that have been identified and mapped along the margin. The authors conclude with a discussion of margin evolution that includes this structural information as well as models of rift margin evolution.

26970 (DOE/ER/13182–T1, pp. 57-66) **History of studies of the Atlantic margin of the United States.** Drake, C.L. (Dartmouth College, Hanover, NH (USA)). Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

Early views on the continental margin of the eastern United States were derived from studies of land geology, since there was little information available at sea. The National Academy of Sciences formed a Committee on Oceanography in 1927. Its recommendations lead to a series of grants which were used to establish the Woods Hole Oceanography Institute (WHOI) and the steel ketch, Atlantis, was built for WHOI to begin research on the geology of the continental margin. In 1932, the American Geophysical Union organized a symposium on ocean basins and margins to further emphasize the importance of oceanographic research not only from the point of view of the relation of geophysical methods to marine geophysical problems, but also the development of a reasonably sound method of attack. The first seismic refraction measurements on the Atlantic shelf were made in 1935 off Woods Hole and Virginia. Two more seismic sections were shot across the coastal plain in New Jersey in the late 1930s.

26971 (DOE/ER/13182–T1, pp. 67-85) **Mesozoic and Cenozoic stratigraphy of the United States Atlantic continental shelf and slope.** Poag, C.W. (Geological Survey, Woods Hole, MA (USA)); Valentine, P.C. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

Geologic and geophysical knowledge of the U.S. Atlantic margin has advanced rapidly during the last ten years, spurred on by commercial interest in offshore petroleum exploration. The U.S. Geological Survey, in particular, has been instrumental in providing thousands of line-kilometer of seismic reflection, geomagnetic, and gravity surveys. As a result of these research efforts, four major offshore basins and troughs have been identified. In this chapter, the authors summarize the stratigraphic framework and depositional history of the three best studied features (Georges Bank basin, Baltimore Canyon trough, and Blake Plateau basin), emphasizing their main features with a cross section through each basin.

26972 (DOE/ER/13182–T1, pp. 87-105) **Geology of the northern Atlantic coastal plain: Long Island to Virginia.** Olsson, R.K. (Rutgers, The State Univ. of New Jersey, New Brunswick (USA)); Gibson, T.G.; Hansen, H.J.; Owens, J.P. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The northern Atlantic coastal plain forms the western margin of the Baltimore Canyon Trough, a large sedimentary basin that underlies the continental shelf along the Middle Atlantic states. Deposition in the coastal region is related to the development of the Baltimore Canyon Trough, which took place during the postrift phase of the opening of the Atlantic Ocean. Sedimentation began on the coastal plain during the early Cretaceous (Neocomian) or possibly late Jurassic time with deposition of fluvial sands, gravels, and variegated clays. The lower Cretaceous stratigraphic sequence is composed almost entirely of sediments of continental (fluvial) origin. In the distal downdip parts of the coastal plain, marine fossils (molluscs, dinoflagellates, and foraminifers) occur in the lower Cretaceous section in some wells suggesting that the coastal plain was influenced from time to time by marginal marine incursions. A major cycle or sea level rise, which began during Albian time in the Baltimore Canyon Trough, led to the spread of the seas over the coastal plain for the first time in the Cenomanian. Following this rise, until Pleistocene time, marine deposition influenced the coastal plain. The sediments consist of coastal deposits of beach, lagoon, marsh, and related deposits; inner shelf sediments of shoreface sands and related delta front facies of micaceous clay and silty, thinly bedded fine sands; mid and outer shelf clayey glauconite sands and glauconitic clays, often extensive burrowed; and slope deposits composited of calcareous clays and silts. The formations of these various facies were deposited during major cycles of sea level change and they are genetically linked to most of the sedimentary units found further offshore in the Baltimore Canyon Trough.

26973 (DOE/ER/13182–T1, pp. 107-130) **Late Mesozoic and early Cenozoic geology of the Atlantic coastal plain: North Carolina to Florida.** Gohn, G.S. (Geological Survey, Reston, VA (USA)). Geological Society of America, Boulder, CO (USA). 1988.

In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The Atlantic Coastal Plain is a physiographic surface of low relief that is underlain by a mildly deformed, seaward-dipping wedge of Mesozoic and Cenozoic sediments. It constitutes a major segment of the Atlantic continental margin of the United States. In this chapter, the Mesozoic and early Cenozoic geologic history of the southern part of the Atlantic Coastal Plain, recorded within the Coastal Plain sediments, is reviewed within the broader context of the development of the entire continental margin.

26974 (DOE/ER/13182–T1, pp. 131-176) **Upper Cenozoic processes and environments of continental margin sedimentation: Eastern United States.** Riggs, S.R. (East Carolina Univ., Greenville, NC (USA)); Belknap, D.F. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The upper Cenozoic record of the Atlantic continental margin is characterized by rapidly changing sedimentary processes and environments of deposition and erosion as compared to the Paleogene. First there were the extreme differences between glacial and interglacial episodes, as well as the transitions into and out of both extremes. Second, there were strong latitudinal shifts of climatic zones and environments that affected oceanographic conditions, biological zonations, and weather processes associated with sediment production and soil formation. Third, major fluctuations in sea level caused rapid migrations of the shoreline and associated nonmarine and marine environments and processes across the continental margin. In glaciated regions, processes were dominated by glacial ice erosion and deposition and by glacial isostasy. In non-glaciated regions, the continental margin was dominated by alternating marine and nonmarine environments in which the stratigraphy was further complicated by interacting processes of deposition, erosion, and diagenesis. These changes have taken place on a stage with structural and stratigraphic underpinnings related to rifting and post-rift subsidence, which have continuously impacted large-scale patterns of sedimentation.

26975 (DOE/ER/13182–T1, pp. 177-196) **Geophysical data.** Sheridan, R.E. (Rutgers, The State Univ. of New Jersey, New Brunswick (USA)); Grow, J.A.; Klitgord, K.D. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

Understanding the geology of the U.S. Atlantic margin is based on a sparse set of drilling and dredge data integrated with a much larger base of geophysical data. Geophysical data provide the primary basis for interpreting structural features and extrapolating from the sparse geological control. The purpose of this chapter is to present the scope of geophysical data coverage of the Atlantic continental margin in a general review format. The discussion touches on the kinds of data produced by different technologies, the historical reasons for the use of various methods, and the improvement of methods.

26976 (DOE/ER/13182–T1, pp. 197-216) **Late Triassic-Early Jurassic synrift basins of the U.S. Atlantic margin.** Manspeizer, W. (Rutgers, The State Univ. of New Jersey, Newark (USA)); Cousminer, H.L. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

As the late Triassic land mass drifted north, perhaps over a field of hot spots or across a tensional stress field, its crust was pulled apart along older fracture zones, sutures, and transforms. The landscape was marked by high-standing coastal ranges with synrift depositional basins that bordered a narrow band of salt flats, which were overlain by shallow, hypersaline waters derived from the Tethys Ocean to the east and/or from arctic Canada to the north. Continued displacement along east-west trending transforms, coupled with extension along the proto-Atlantic axis, finally broke the narrow platform into multiple basins near the end of the Triassic and beginning of the Jurassic, thus bring to a close the early rifting stage of the passive margins. Intermittent episodes of rifting and drifting followed into the Early Jurassic. Since the middle Jurassic, however, the U.S. margin has been dominated by regional subsidence (drifting stage), so that today the record of Triassic-Liassic rifting is buried under a vast prism of postrift and drift sediment. Because of the offshore Triassic-Jurassic synrift data base is limited primarily to geophysical data that are presented by others, this paper focuses on the rocks of the offshore and onshore basins, because these rocks provide additional data yielding some answers to vexing questions surrounding the origin of synrift basins and the history of the U.S. Atlantic passive margin.

26977 (DOE/ER/13182–T1, pp. 217-241) **Mesozoic and Cenozoic magmatism.** de Boer, J.Z. (Wesleyan Univ., Middletown, CT (USA)); McHone, J.G.; Puffer, J.H.; Ragland, P.C.; Whittington, D. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

Mesozoic and early Cenozoic magmatism in eastern North America produced distinct provinces with characteristic igneous and tectonic styles. This chapter is arranged in order of age and province size and is primarily descriptive in nature. Some of the igneous events are not well dated and thorough chemical and petrographic analyses may also be lacking. The authors outline present knowledge of the provinces and synthesize some of the more important aspects of the rocks and events that produced them.

26978 (DOE/ER/13182–T1, pp. 243-268) **Georges Bank basin: A regional synthesis.** Schlee, J.S. (Geological Survey, Woods Hole, MA (USA)); Klitgord, K.D. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

Georges Bank is a shallow part of the Atlantic Continental Shelf southeast of New England. This bank, however, is merely the upper surface of several sedimentary basins overlying a block-faulted basement of igneous and metamorphic crystalline rock. Sedimentary rock forms a seaward thickening cover that has accumulated in one main depocenter and several ancillary depressions, adjacent to shallow basement platforms of Paleozoic and older crystalline rock. Georges Bank basin contains a thickness of sedimentary rock greater than 10 km, whereas the basement platforms that flank the basin are areas of thin sediment accumulation (less than 5 km). In this chapter, the authors discuss the structural, stratigraphic, and tectonic framework of the Georges Bank area, presenting a synthesis of geophysical and geological data, much of which has been collected over the past decade. In particular, they are concerned with the crustal foundations of Georges Bank, the main stages of sedimentary buildup, and the forces that we think have influenced the evolution of the basin.

26979 (DOE/ER/13182–T1, pp. 269-290) **Structure and evolution of Baltimore Canyon Trough.** Grow, J.A. (Geological Survey, Denver, CO (USA)); Klitgord, K.D.; Schlee, J.S. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The Baltimore Canyon Trough is the deepest depocenter for Mesozoic and Cenozoic sedimentary rocks along the U.S. Atlantic continental margin, with up to 18 km deposited beneath the continental shelf off New Jersey. Baltimore Canyon was initially formed in response to extensional rifting between North America and Africa during the Triassic through early Jurassic time, which was followed by sea-floor spreading in the early middle Jurassic. The Trough has been the focus of frontier research ever since marine refraction surveys of continental shelf were conducted off New Jersey over

50 years. The purpose of this chapter will be to summarize the major structural and stratigraphic features of Baltimore Canyon Trough and its tectonic evolution, primarily using seismic-reflection profiles.

26980 (DOE/ER/13182–T1, pp. 291-328) **The Blake Plateau Basin and Carolina Trough.** Dillon, W.P.; Popenoe, P. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The region of the continental margin is underlain by two major sedimentary basins - the Blake Plateau Basin and the Carolina Trough - which are different in shape, basement structure, and history. These two southern basins show some of the greatest contrasts of any basins of eastern North America, especially in their early response to rifting and in the change from rifting to drifting. The region has experienced abrupt major changes in geological conditions, most notably the onset of Gulf Stream flow in the early Tertiary. In this chapter, the authors identify five stages of continental margin development off the southeastern U.S. They also trace the geologic history of the Blake Plateau Basin and the Carolina Trough.

26981 (DOE/ER/13182–T1, pp. 329-364) **Geology and geophysics of the Bahamas.** Sheridan, R.E. (Univ. of Delaware, Newark (USA)); Mullins, H.T.; Austin, J.A. Jr.; Ball, M.M.; Ladd, J.W. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The broad, shallow banks and intervening deep water channels of the Bahama Platform are unlike any other topography on the larger Atlantic margin. The Bahama Platform covers roughly an area of 470,000 square kilometers, which is nearly equivalent to the area of the exposed Atlantic coastal plain from Cape Hatteras to Florida. In this chapter, the authors summarize previous geological research on the Bahamas and discuss new data and interpretations. Deep seismic structure, gravity anomalies, magnetic anomalies, deep stratigraphy, modern carbonate sedimentology, geologic history, and geologic resources are also discussed.

26982 (DOE/ER/13182–T1, pp. 365-385) **Paleoenvironments: Offshore Atlantic U.S. margin.** Schlee, J.S. (Geological Survey, Woods Hole, MA (USA)); Manspeizer, W.; Riggs, S.R. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The U.S. Atlantic continental margin stretches 1,850 km from Georges Bank in the north to the Blake Plateau in the south, encompassing an area of 655,000 square kilometers. The margin comprises several sedimentary basins of different shapes with platforms in between. The basins appear to have begun their subsidence at about the same time and to have undergone similar rift and post-rift phases of development that resulted in a similar sedimentary section. The authors' objective in this paper are: (1) to portray, at selected intervals, the paleogeography of the margin during the Mesozoic and Cenozoic; (2) to discuss the temporal development of the paleoshelf edge; and (3) to outline the major elements of the several different sedimentary regimes that have prevailed (rift, post-rift, carbonate-clastic, and authigenic sediments accumulations).

26983 (DOE/ER/13182–T1, pp. 387-398) **A large aperture seismic experiment in the Baltimore Canyon Trough.** Diebold, J.B. (Columbia Univ., Palisades, NY (USA)); Stoffa, P.L. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

A large aperture seismic experiment (LASE) was conducted in the area of the Baltimore Canyon Trough by scientists and ships from the Lamont-Doherty Geological Observatory of Columbia University, the Woods Hole Oceanographic Institution, the University of Texas Institute of Geophysics, and the Bedford Institute of Oceanography. The main scientific objectives were defined by questions arising from the analysis of USGS Line 25. These included determining the nature of material underlying Jurassic carbonates and the existence of an underlying basement ridge at the present shelf edge. It was also hoped that any structures associated with the east coast magnetic anomaly might be revealed. It was expected that the large offsets employed in the multi-ship CDP profiling method would allow improved velocity resolution and better rejection of multiple reverberation than in the case of conventional, single ship data. Since this project involved innovative techniques of acquisition, processing, and analysis, it is necessary to describe them to some extent. The geological results are no less important, however, and provide important benchmarks for future interpretations of the development of the North Atlantic margin.

26984 (DOE/ER/13182–T1, pp. 399-416) **Subsidence and basin modeling at the U.S. Atlantic passive margin.** Steckler, M.S. (Columbia Univ., Palisades, NY (USA)); Watts, A.B.; Thorne, J.A. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The U.S. Atlantic margin seaward of the hinge zone has been subjected to extensive net crustal thinning. Because of the body of well data in this region only penetrates the last third of the tectonic subsidence, the lithospheric heating during rifting and synrift subsidence are not well constrained. Thus the resolution of present data does not allow firm conclusions as to whether or not the extension was uniform seaward of the hinge zone. The lack of Jurassic sediments landward of the hinge zone. The lack of Jurassic sediments landward of the hinge zone, on other hand, provides clear evidence of extensive heating in a zone of little crustal thinning. In contrast to the more seaward parts of the margins, which experienced considerable subsidence and sediment accumulation during rifting, the portions landward of the hinge zone were uplifted and eroded. Small-scale convection driven by the rifting process is a possible mechanism consistent with the observations. Data from this less extended part of the margin is critically needed to constrain models of convective and flexural effects.

26985 (DOE/ER/13182–T1, pp. 417-428) **Thermal evolution.** Sawyer, D.S. (Univ. of Texas, Austin (USA)). Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

In this chapter the authors describe the few thermal measurements that have been made on the U.S. Atlantic Continental Margin and then show some of the forward modeling that has been used to predict paleotemperatures and estimate kerogen alteration there. During the modeling of three Atlantic marginal basins, similarities and differences between them became apparent. Two properties of the basins emerged as important to their large-scale development: the sediment supply and the configuration of the thinned continental or rift-stage crust under the margin. The lateral change in the thickness of rift-stage crust, determined by thermal and gravity modeling, suggests how the crust responded to extension during continental breakup. The models indicate that it may be possible to predict the maximum sediment thickness temperature, and hydrocarbon source maturity for a marginal basin knowing only the location of the continental shelf edge and of the boundary between rift-stage and oceanic crust.

26986 (DOE/ER/13182–T1, pp. 429-436) **Sea-level changes and their effect on the stratigraphy of Atlantic-type margins.** Pitman, W.C. (Columbia Univ., Palisades, NY (USA)); Golovchenko, X. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

In recent years there has been increased interest in the Atlantic margin and other passive margins both because of the hydrocarbon potential and because the very thick, relatively undisturbed sedimentary section provides a singular opportunity for stratigraphic studies. In this paper, the objective is to point out some of the difficulties in interpretation of the patterns of depositional sequences at an Atlantic-type margin in terms of eustasy and to show that the correlation of transgressive and regressive events within a basin, between basins, and with a temporal pattern of sea-level change may be subject to errors of up to 3 m.y.

26987 (DOE/ER/13182–T1, pp. 437-444) **Seismic stratigraphic and geohistory analysis of Tertiary strata from the continental shelf off New Jersey: Calculation of eustatic fluctuations from stratigraphic data.** Greenlee, S.M. (Exxon Production Research Co., Houston, TX (USA)); Schroeder, F.W.; Vail, P.R. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

In this paper, the authors present the results of a study in which we apply seismic stratigraphic and geohistory analysis techniques to data from the Baltimore Canyon trough to interpret sea-level changes during the Tertiary. First, they develop a stratigraphic framework for the study area through the interpretation of a regional grid of seismic reflection data tied to available well control. Then, the authors use the ages of the major depositional sequence boundaries at the COST B-2 well site to predict the thermotectonic subsidence of the basin since the early Jurassic and to estimate long-term sea-level changes. Finally, they analyze the Tertiary sedimentary patterns expressed in seismic and well data to derive a detailed curve of eustatic changes of sea level.

26988 (DOE/ER/13182–T1, pp. 463-480) **Hydrogeology of the Atlantic continental margin.** Kohout, F.A. (Geological survey, Woods Hole, MA (USA)); Meisler, H.; Meyer, F.W.; Johnston, R.H.; Leve, G.W.; Wait, R.L. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

This paper links extensive hydrogeologic investigations on the Atlantic coastal plain of the United States with geologic and oceanographic studies related to oil exploration on the Atlantic Continental Margin. Changing sea level caused by ice accumulation during the Pleistocene glacial epoch greatly influenced the recharge, storage, and movement of fresh ground water along the entire reach of the Atlantic seaboard. In the south, artesian aquifers of relatively high permeability convey fresh ground water seaward in coastal plain sediments more or less in hydrodynamic equilibrium with the present level of the sea. In the north, low permeability confining beds and rapid overflooding during the last stages of glacial melting have trapped fresh ground water in artesian aquifers underlying the continental shelf. The intent of this synthesis is to integrate research studies on saltwater intrusion and geographic occurrence of fresh ground water to describe the complex circulation systems that presently exist.

26989 (DOE/ER/13182–T1, pp. 481-500) **Sand and gravel resources: U.S. Atlantic continental shelf.** Duane, D.B. (NOAA, Rockville, MD (USA)); Stubblefield, W.L. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

Estimates of sand and gravel resources the U.S. Atlantic Continental Shelf is approximately 2.0 X 12^{12} cubic meters for the North Atlantic Province; 2.6 X 12 cubic meters for the Middle Atlantic Province; and 2.2 X 10^{11} cubic meters for the South Atlantic Province. Most of this sediment is sand size material with mineralogy varying between arkosic and suborthquartzitic. In the South Atlantic Province, the carbonate content in the surficial sands increases from trace amounts north of Cape Lookout, North Carolina, to in excess of 75% south of Palm Beach Florida. Gravels are common on the glaciated shelves of the North Atlantic Province and in a few relict fluvial channels off the New Jersey coast. Elsewhere gravel deposits are rare. Recent research efforts assessing the impact of marine aggregate recovery have shown dredging and rehandling operations produce impacts ranging from detrimental, to beneficial, or may have no discernible effect. Moreover, it is apparent that consequences now are predictable and that careful planning prior to operations can minimize undesirable ecological effects.

26990 (DOE/ER/13182–T1, pp. 501-520) **Mineral resources of the U.S. Atlantic continental margin.** Riggs, S.R. (East Carolina Univ., Greenville, NC (USA)); Manheim, F.T. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

At present, most hard mineral extraction industries of the Atlantic Continental margin are located on the coastal plain. These resources are fairly well known and constitute a large portion of this chapter. Offshore resources must deal with the potential, but since the continental shelves are geologically only submerged portions of the continent, it is logical to assume that the mineral potential should be comparable to that found on land. Those resources considered in this chapter include minerals that either have been recovered, are presently being recovered, or are known to occur in significant concentrations to be considered potential future resources. This chapter excludes petroleum, water, and sand and gravel resources. It includes: phosphates and their by-products; manganese and associated metal oxides; heavy mineral placers; clay deposits; carbonates; diatomites; evaporites; and peats.

26991 (DOE/ER/13182–T1, pp. 549-556) **Coastal geologic hazards.** Pilkey, O.H. (Duke Univ., Durham, NC (USA)); Neal, W.J. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

In view of the continued growth in coastal zone population and infrastructure, the failure of the engineered structural approach to eliminate or effectively mitigate coastal hazards, and the more recent complicating factor of an accelerated sea level rise, it appears that the stage is set for at least a partial withdrawal of development from the shore. Many of the uses of the coastal zone are of a conflicting nature, virtually assuring continuing and accelerating environmental crises in the future. Recreational and commercial fishing, military use, transportation, mineral extraction, and waste disposal are all human activities that cannot co-exist peacefully. Because of the breadth of coastal environmental hazards, solutions to the environmental problems are not a purely scientific endeavor. As in all of society's environmental problems, strong overtones of politics and economics exist. A society must establish its own limits and priorities regarding coastal zone use and management, and no two societies will view environmental problems in the same fashion. One fact is certain, however, without strong and effective coastal management policies that cross state and national boundaries, the environmental crisis at the shore can only worsen, to the detriment of all segments of society.

26992 (DOE/ER/13182–T1, pp. 557-564) **Cretaceous and Cenozoic tectonism on the Atlantic coastal margin.** Prowell, D.C. (Geological Survey, Doraville, GA (USA)). Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

This /paper briefly summarizes the nature of faulting and associated tectonism in the eastern United States from the Cretaceous to the present. Studies of reverse faults indicate that regional compression has existed in the crust from the early Cretaceous through the Pleistocene, but evidence of earlier movements is not available. Intrusion of diabase dikes and rift basin sedimentation from Triassic to the Middle Jurassic, however, suggests that tensional forces associated with rifting were still present at that time. Cretaceous and younger faults in the United States may form

along preexisting Paleozoic or Mesozoic faults, but they generally parallel local rock fabric. The location of the plane of both the local orientation of maximum compressive stress and the orientation and mechanical properties of planar geologic elements. Shear zones that are not oriented at right angles to the maximum compressive stress will have oblique-slip reverse movement. The long-term compression since the Early Cretaceous is apparently responsible for rather uniform fault movement for the last 110 m.y. The presence of compressive stress and reverse fault movement in the recent geologic record is inferred by seismic focal plane solutions and modern stress measurements. However, offsets in Holocene strata have not been recognized, probably because of the lack of significant amounts of fault movement. Other evidence of possible crustal tectonism is uplift, tilting, and subsidence manifested as coastal arches, embayments, and troughs, which are further modified by sediment loading.

26993 (DOE/ER/13182–T1, pp. 565-582) **Seismicity along the Atlantic seaboard of the U.S.: Intraplate neotectonics and earthquake hazard.** Seeber, L. (Columbia Univ., Palisades, NY (USA)); Armbruster, J.G. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

Seismicity along the Atlantic Seaboard is moderately high for an intraplate region and includes large damaging earthquakes. Although the rate of moment release in this and other areas of the eastern U.S. is low when compared to the moment release along plate boundaries, this rate seems high when contrasted with the low rate of intraplate deformation inferred from geologic data. The apparent contradiction between earthquake and geologic data in intraplate eastern U.S., however, stems from a comparison /with seismicity and strain rates in interplate western U.S. The Appalachian Front, defined as the northwestern limit of the allochthonous crystalline slab above the master detachment appears to control the spatial distribution of seismicity on a large scale. At an intermediate scale, seismicity is also often controlled by preexisting structure. The Newark Basin, for example, is itself aseismic while seismicity is concentrated around the border of the basin. Similar patterns of seismicity along the Atlantic Seaboard are seen in the historic data, which are dominated by felt evens, and in recent instrumental data, which include much smaller earthquakes. Although an understanding of the tectonic processes that could cause coherent changes of seismicity over large areas is still lacking, nonstationarity in the seismic regime needs to be incorporated into realistic estimates of earthquake hazard in the eastern U.S.

26994 (DOE/ER/13182–T1, pp. 583-593) **Waste disposal in the Atlantic continental margin.** Palmer, H.D. (FEMTO Associates, Bethesda, MD (USA)). Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The level of concern expressed by commercial fishermen, coastal Chambers of Commerce, public, and private organizations concerned with the serious questions of environmental impacts of waste disposal, and others who have legitimate questions regarding the quality of marine and estuarine waters had become a major issue in coastal communities. Projects by the U.S. Census Bureau suggest an 8 percent gain in population of all states bordering the Atlantic Ocean by the year 2000. The greatest growth will be in the central and southern states, and estimates show a decline of 15 percent during this period in New York. These data suggest that by 2000, the 71.6 million inhabitants of these coastal states will make further demands upon inland waters and estuaries, the coastal zone, and offshore marine environments. Increased population guarantees increased waste production, and the need for prudent and timely decisions will be a paramount concern of state and federal legislators. As pointed out by the authors, geologists, and especially marine geologists and sedimentologists, have a clear responsibility to become involved in decision-making processes affecting the choices of waste-disposal alternatives. Their assessment of waste-management practices becomes a critical factor in making rational choices which minimize the impacts of disposal practice.

26995 (DOE/ER/13182–T1, pp. 595-599) **Synthesis and unanswered questions.** Sheridan, R.E. (Rutgers, The State Univ. of New Jersey, New Brunswick (USA)); Grow, J.A. Geological Society of America, Boulder, CO (USA). 1988. In *The Atlantic continental margin: US. Decade of North American Geology Project.* Order Number DE90007277. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

This chapter summarizes the major findings of the previous 31 chapters of the book and highlights the critical factors in the geologic development of the U.S. Atlantic Continental Margin. In addition, the authors point out the limitations of the syntheses as a warning that much of what is written is speculative, based on inconclusive data, and/or somewhat dated.

26996 (DOE/ER/13182–T2, pp. 1-3) **Introduction.** Sloss, L.L. (Northwestern Univ., Evanston, IL (USA)). Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

This volume is devoted to the Phanerozoic sedimentary strata covering the largely, but by no means exclusively, crystalline rock of that part of the North American Craton in the continetal United States. In this introductory chapter, the term craton is defined and the chronologic subdivisions for analysis of cratonic history are discussed.

26997 (DOE/ER/13182–T2, pp. 5-24) **Geophysical aspects of the craton: U.S.** Hinze, W.J. (Purdue Univ., West Lafayette, IN (USA)); Braile, L.W. Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The midcontinent province between the Appalachian-Ouachita orogen and the Rocky Mountains is that portion of the United States craton which has been relatively stable tectonically for roughly the past billion years. Diastrophism has been restricted largely to broad, slow, vertical movements and highly attenuated, passive response to orogenic activity, which has occurred at plate margins around the North American craton. Thus, except for very localized structures associated with rare anorogenic intrusions and meteorite impacts, the Phanerozoic sedimentary rocks are only disturbed by minor faulting and gentle warping. A/s a result, regional geophysical investigations of the midcontinent have primarily focused on the study of the more laterally variable physical properties of the crystalline rocks of the basement and deeper portions of the crust. However, a great number of detailed geophysical investigations have been conducted over cratonic basins in the search for structural and stratigraphic variations within the Phanerozoic sedimentary rocks. With a few notable exceptions, these surveys, largely seismic reflection and gravity, have been conducted to locate hydrocarbon accumulations and consequently are represented by proprietary data.

26998 (DOE/ER/13182–T2, pp. 25-51) **Tectonic evolution of the craton in Phanerozoic time.** Sloss, L.L. (Northwestern Univ., Evanston, IL (USA)). Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

This chapter summarizes the tectonic history of the North American craton south of the Canadian border and north of the Mojave-Sonora megashear or northern Mexico from the latest Proterozoic to present. The tectonic evolution of cratons is most readily deciphered by analysis of the preserved cover rocks and their distributions and thicknesses, their petrologic characteristics and fossils, and the regional and interregional unconformities that punctuate the stratigraphic record. Interpretations of cratonic evolution are further refined by consideration of deposition environments

and provenance identity derived from the petrologic and paleobiologic content of accumulated sediment and from the deduced distributary paths of detrital materials. In this chapter, emphasis is polaced on truly interregional surfaces marking interruptions in the continuity of sedimentation across the entire craton.

26999 (DOE/ER/13182–T2, pp. 53-64) **Triassic and older stratigraphy: Southern Rocky Mountains and Colorado Plateau.** Baars, D.L. Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The geologic history and Triassic and older stratigraphy of the Southern Rocky Mountains and Colorado Plateau is discussed. Sections are included on the stratigraphic of the Precambrian Era, Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian, Permian, and Triassic periods, along with a section on the Permo-Triassic boundary.

27000 (DOE/ER/13182–T2, pp. 83-107) **Phanerozoic stratigraphy of the northern Rocky Mountain region.** Peterson, J.A. (Univ. of Montana, Missoula (USA)). Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The northern Rocky Mountain region contains a relatively complete Phanerozoic stratigraphic section ranging in age from Cambrian to Holocene. Thickness of Paleozoic rocks are as much as 9,000 meters in southeast Idaho, 3,000 meters in southwest Montana, 2,500 meters in the central part of the Williston Basin, and generally less than 1,500 meters in most of Wyoming, South Dakota, and the remainder of Montana. In this chapter the stratigraphy of the northern Rocky Mountain region is discussed by periods (Cambrian-Tertiary).

27001 (DOE/ER/13182–T2, pp. 243-260) **Phanerozoic history of the central midcontinent, United States.** Bunker, B.J. (Geological Survey, Iowa City, IA (USA)); Witzke, B.J.; Watney, W.L.; Ludvigson, G.A. Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The region of the central midcontinent has commonly been termed the stable interior of the North American continent. The magnitudes of Phanerozoic crustal deformation in the cratonic interior certainly are very small compared to those known from active continental margins, and the rates of deformation have been generally slower. Nevertheless, the Phanerozoic sedimentary record in the central midcontinent region is replete with evidences of tectonic activity of surprising diversity and pattern. The central midcontinent, as defined in this chapter, includes Iowa, Kansas, southeastern South Dakota, Nebraska, southern Minnesota, and Missouri north of the 37°N latitude. The Phanerozoic stratigraphic record in the central midcontinent regino of North America is divided into six major depositional sequences, each bounded by major interregional unconformities. The structural and stratigraphic development of this region is evaluated using a series of isopach and paleogeographic maps constructed wiqthin the general framework of Sloss' (1963, Sequences in the cratonic interior of North America: Geological Society of America Bulletin, v. 74, p. 93-114) cratonic sequence.

27002 (DOE/ER/13182–T2, pp. 307-359) **Southern midcontinent region.** Johnson, K.S. (Univ. of Oklahoma, Norman (USA)); Amsden, T.W.; denison, R.E.; Dutton, S.P.; Goldstein, A.G.; Sutherland, P.K.; Thompson, D.M.; Rascoe, B. Jr. Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The Southern Midcontinent is a complex region characterized by great thicknesses of sediments preserved in a series of major depositional and structural basins separated by orogenic uplifts created mainly during Pennsylvanian time. Dominant lithologies in most basins of the region are, in ascending order, as follows: a thin transgressive sandstone of Late Cambrian age that covered the basement rock complex of intrusives, extrusives, and metasediments; overlain by a thick sequence of Late Cambrian through Late Mississippian carbonates, with minor amounts of sandstones and shale; followed by a thick sequence of terrigenous clastics, with some carbonates deposited in the Late Mississippian through Early Permian time; then a thick series of red beds and evaporites were deposited during the remainder of the Permian; overlain, in the west only, by Triassic and Jurassic terrestrial red beds; then Cretaceous marine deposits in the south and west; and finally a mantle of Tertiary alluvial-fan, aeolian, and lacustrine sediments in the west. The Southern Midcontinent contains one of the greatest thicknesses of sedimentary rocks preserved in North America, with as much as 12,000 meters of strata in the deep Andarko Basin. Other major accumulations of sediments are in the Ardmore Basin (about 9,000 m), the southern part of the Arkoma Basin (about 8,000 m), the Marietta Basin (about 8,000 m), and the Palo Duro, Dalhart, Hardeman, and Fort Worth Basins (each which contain 3,000 to 4,000 m). The Phanerozoic history of the Southern Midcontinent is characterized by three major periods of tectonics and sedimentation: early and late phases of broad subsidence and epeirogenic movements were interrupted by a middle phase of sharp orogenic uplift and deep subsidence.

27003 (DOE/ER/13182–T2, pp. 361-382) **Michigan basin.** Fisher, J.H. (Michigan State Univ., East Lansing (USA)). Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The geology of the Michigan Basin is discussed. Sections on structure and tectonics; geologic evolution; and stratigraphy are presented and the Michigan basin is compared to other basins. Energy, mineral, and water resources are also discussed. At present, oil and gas production revenues account for the two highest resource values.

27004 (DOE/ER/13182–T2, pp. 383-426) **Illinois basin region.** Collinson, C. (Illinois State Geological Survey, Champaign (USA)); Sargent, M.L.; Jennings, J.R. Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The geology of the Illinois Basin is discussed. The structural setting, geologic history, and stratigraphy is detailed.

27005 (DOE/ER/13182–T2, pp. 427-469) **The Appalachian basin.** Milici, R.C. (Virginia Div. of Mineral Resources, Charlottesville (USA)); de Witt, W. Jr. Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

Although the general stratigraphic framework of the Appalachian Basin has been known for many years, its development was placed in a plate tectonic context only during the last two decades. The timing and nature of the Late Proterozoic and Paleozoic plate tectonic events in the crystalline hinterland of the Appalachians relate directly to the evolution of the basin. Problems still exist at all scales, however. Regional stratigraphic relationships in the Appalachian Valley and Ridge are not much better understood than they were a generation ago. Interregional correlations between the exposed Paleozoic rocks in the mountains and the subsurface strata along the Cincinnati Arch to the west have not been documented satisfactory. A better understanding of the Appalachian Basin will require an integrated approach, involving stratigraphic and biostratigraphic studies that are closely related to careful and detailed geologic quadrangle mapping. A detailed stratigraphic framework is essential, too, for paleoenvironmental and paleogeographic studies, as well as for petrologic studies, that would better define the nature and development of siliciclastic source areas.

27006 (DOE/ER/13182–T2, pp. 493-496) **Conclusions.** Sloss, L.L. (Northwestern Univ., Evanston, IL (USA)). Geological Survey, Boulder, CO (USA). 1988. In *Sedimentary cover - North American craton: US. Decade of North American Geology Project.* Order Number DE90007278. Available from Geological Society of America, Inc., 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

The previous 16 chapters of this book are briefly summarized and unresolved questions concerning the North American Craton are discussed.

27007 (GGU-R–145) **Report of activities, 1988.** Groenlands Geologiske Undersoegelse, Copenhagen (Denmark). 1989. 123p. Order Number DE90770704. Available from NTIS (US Sales Only), PC A06/MF A01.

Description of the activities of "Groenlands Geologiske Undersoegelse" during 1988. Investigations were carried out in Greenland, and related mainly to deposits of petroleum, niobium, tantalum, lead, zinc, sulphide and gold mineralizations, graphite, ryholite, and glacio-hydrological studies. (AB).

27008 Metal composition patterns in volcanic gas sublimates: Mauna Loa eruption of April 1984. Bayhurst, G.K. (Los Alamos National Lab., NM (USA)); Janecky, D.R.; Zoller, W. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. . American Chemical Society, Washington, DC (US) (1986). (CONF-8609464–: American Chemical Society Division of Nuclear Chemistry and Technology, Anaheim, CA (USA), 7-12 Sep 1986).

Sublimates were collected during April 15-17, 1984, shortly after the eruption of Mauna Loa. Temperature of volcanic gases sweeping by the sublimate deposits ranged from 700°C within vents to 75°C in areas several meters away from vents. Subsamples of the deposits were examined using XRD SEM, INAA, and DCP-AES. The compositions vary greatly with respect to distance from the vent, due to the mixing of air with the hot volcanic gases. Major compositional zoning relationships with respect to decreasing measured gas temperatures are iron oxide, sodium-sulfate, and elemental sulfur. Other phases identified include ZnS, CuS, SnO, $CaSO_4$, CdS, and $KNaSO_4$. Concentration patterns, relative to temperature of major, minor and trace metals can be divided into several types. Iron, manganese, cobalt, gold, silver, and iridium are positively correlated with temperature, while sodium and tin are low at high temperatures and step to enriched levels at a consistent distance from the vents. Several elements, including antimony and indium exhibit a random pattern. These sublimate analyses provide evidence of significant mobilization and subsequent chemical separation of major, minor and trace metals by processes involving volcanic gases.

27009 Volatile trace element variations in gases and particles from Kilauea volcano. Finnegan, D.L. (Los Alamos National Lab., NM (USA)); Crowe, B.M.; Zoller, W.H. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. . American Chemical Society, Washington, DC (US) (1986). (CONF-8609464–: American Chemical Society Division of Nuclear Chemistry and Technology, Anaheim, CA (USA), 7-12 Sep 1986).

Volcanic particles and gases were collected on the ground and from aircraft during episodic eruptions of Kilauea volcano in 1983 and 1984 using particle filters and a series of base-treated filters. The filters were analyzed for major and minor elements using neutron activation analysis. Enrichment factors were calculated for gas phase elements relative to Hawaiian basalt and many elements were found to be highly enriched including F, S, Cl, As, Se, Br, Ag, Cd, In, Sb, Re, Ir, and Au. Enrichment factors, however, are unsatisfactory for comparing variations between samples because of differing amounts of ash collected on the particle filters. Because enrichment factors are normalized to elements in the ash, small differences in the mass abundance of the ash causes large variations in calculated enrichment factors. This problem was solved by normalizing to a volatile phase with a high solubility in basaltic melt (F or Cl). Volatile-normalized data show systematic abundances of selected trace metals with time through an eruption cycle.

27010 The volcanic source term: Atmospheric emission rates of enriched volatile elements from five volcanoes. Kotra, J.P. (Nuclear Regulatory Commission, Washington, DC (USA)); Zoller, W.H. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. . American Chemical Society, Washington, DC (US) (1986). (CONF-8609464–: American Chemical Society Division of Nuclear Chemistry and Technology, Anaheim, CA (USA), 7-12 Sep 1986).

Atmospheric particles and gases have been collected from aircraft in the non-eruptive plumes of five active volcanoes. Particulate concentrations of up to 30 elements as well as gas phase S, Cl and Br were determined for these samples. The volatile and chalcophilic elements, Cl, Zn, As, Se, Br, Cd, In, Sb, W and Au were found to be highly enriched relative to bulk pyroclastic material. Emission rates of these elements from each volcano were calculated and this overall global volcanic source strengths for several of the enriched elements were found to be significant. Observed differences in the signatures of enriched volatile elements between recently eruptive and quiescent volcanoes will be discussed.

27011 Geological and geochemical record of 3400-million-year-old terrestrial meteorite impacts. Lowe, D.R. (Stanford Univ., CA (USA)); Byerly, G.R.; Asaro, F.; Kyte, F.T. *Science (Washington, D.C.) (USA),* 245(4921): 959-962 (1 Sep 1989). DOE Contract AC03-76SF00098.

Beds of sand-sized spherules in the 3400-million-year-old Fig Tree Group, Barberton Greenstone belt, South Africa, were formed by the fall of quenched liquid silicate droplets into a range of shallow- to deep-water depositional environments. The regional extent of the layers, their compositional complexity, and lack of included volcanic debris suggest that they are not products of volcanic activity. The layers are greatly enriched in iridium and other platinum group elements in roughly chondritic proportions. Geochemical modeling based on immobile element abundances suggests that the original average spherule composition can be approximated by a mixture of fractionated tholeiitic basalt, komatiite, and CI carbonaceous chondrite. The spherules are thought to be the products of large meteorite impacts on the Archean earth. 21 refs., 4 figs., 1 tab.

27012 Three-dimensional spherical models of convection in the earth's mantle. Bercovici, D. (Univ. of California, Los Angeles (USA)); Schubert, G.; Glatzmaier, G.A. *Science (Washington, D.C.) (USA),* 244(4907): 950-955 (26 May 1989).

Three-dimensional, spherical models of mantle convection in the earth reveal that upwelling cylindrical plumes and downwelling planar sheets are the primary features of mantle circulation. Thus, subduction zones and descending sheetlike slabs in the mantle are fundamental characteristics of thermal convection in a spherical shell and are not merely the consequences of the rigidity of the slabs, which are cooler than the surrounding mantle. Cylindrical mantle plumes that cause hotspots such as Hawaii are probably the only form of active upwelling and are therefore not just secondary convective currents separate from the large-scale mantle circulation. Active sheetlike upwellings that could be associated with mid-ocean ridges did not develop in the model simulations, a result that is in agreement with evidence suggesting that ridges are passive phenomena resulting from the tearing of surface plates by the pull of descending slabs. 36 refs., 3 figs.

27013 Effects of contact metamorphism on the chemistry of calcareous rocks in the Big Horse Limestone Member, Notch Peak, Utah. Labotka, T.C. (Univ. of Tennessee, Knoxville (USA)); Nabelek, P.I.; Papike, J.J.; Hover-Granath, V.C. *American Mineralogist (USA),* 73(9-10): 1095-1110 (Sep-Oct 1988). DOE Contract FG01-85ER13407.

The Jurassic Notch Peak stock intruded Upper Cambrian limestones and calcareous argillites of the Big Horse Limestone Member of the Orr Formation in west-central Utah. Previous petrologic and stable-isotope studies showed that the argillites interacted with more than two rock volumes of externally derived H_2O, whereas the limestones were impervious to the infiltrating fluid. Thirty-four major, minor, and trace elements were analyzed in argillites and limestones to determine whether the substantial influx of H_2O from the crystallizing pluton caused a change in the composition of the host rocks. The variance in the major-element chemistry can be explained accurately by three sedimentary components: calcite, quartz + feldspar, and mica. The siliciclastic

components were probably sorted independently in the sedimentary environment because of differences in grain shape. The abundances of all trace elements, except Sr, are strongly correlated with geochemically similar major elements. Sr shows very poor correlation with Ca in argillite samples and has enhanced abundances in some high-grade samples. The anomalous samples also contain high abundances of Ba, Rb, and K, and a cluster analysis groups Sr with these elements. The poor correlations among Sr and the other elements are caused by its dual affinity for alkali feldspar and calcite. The high abundance of feldspar in some high-grade samples indicates that feldspar components migrated over a volume of about 2 L during recrystallization of coarse-grained vesuvianite- and garnet-bearing samples. The results of the study indicate that there was no detectable, systematic change in composition with metamorphic grade. There is no evidence for large-scale migration of major of trace elements, despite the apparent substantial infiltration of H_2O during metamorphism.

27014 Fluid infiltration through the Big Horse Limestone Member in the Notch Peak contact-metamorphic aureole, Utah. Labotka, T.C. (Univ. of Tennessee, Knoxville (USA)); Nabelek, P.I.; Papike, J.J. *American Mineralogist (USA)*, 73(11-12): 1302-1324 (Nov-Dec 1988). DOE Contract FG01-85ER13407.

Calcareous argillites in the Upper Cambrian Big House Limestone Member of the Orr Formation, west-central Utah, have undergone contact metamorphism where they were intruded by the Jurassic Notch Peak stock. Metamorphism of the rocks resulted in nearly complete decarbonation, yet the mineral assemblages indicate that the fluid phase was nearly free of CO_2, indicating interaction with a substantial volume of water. This study is designed to determine the volume of externally derived water with which the Big Horse Limestone Member interacted and the mode of interaction. The rocks in the aureole are characterized by three grades of metamorphism, separated by the diopside and the wollastonite isograds. Simple calculations of the temperature and fluid flux through the aureole, based on heat- and fluid-transport equations, indicate that heat transport on the margins of the stock occurred primarily by conduction, particularly outside the wollastonite zone, and that the major fluid flux through the aureole occurred within the first year of intrusion, long before the temperature had risen sufficiently for metamorphism to have occurred. Fluid fluxes through the aureole after 1000 yr, when significant metamorphism occurred, dropped to the order of 1 kg/(m^2 yr), or less. This amount is sufficient to have interacted with the diopside-zone rocks, giving water/rock ratios (by mass) of the order 0.1. The fluid flux through the wollastonite zone is given by the rate of advancement of the isograd, which gives fluxes ranging from >42 kg/(m^2 yr) at 50 m from the contact to 0 kg/(m^2 yr) at the maximum distances of 410 m. The results of this study indicate that in those metamorphic terranes in which there is a change from rock-dominated to fluid-dominated systems across an isograd, the water rock ratio in the fluid-dominated system represents not the fluid flux.

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Refer also to citation(s) 27031, 27050, 27077, 27184

27015 (AD-A–216204/8/XAB) **Shear-induced inflation of coronal magnetic fields.** Klimchuk, J.A. Stanford Univ., CA (USA). Center for Space Science and Astrophysics. 5 Aug 1989. 31p. Available from NTIS, PC A03/MF A01.

Using numerical models of force-free magnetic fields, we have examined how the shearing of footpoints in arcade geometries leads to an inflation of the coronal magnetic field. For each of the shear profiles considered, all of the field lines become elevated compared with the potential field. This includes cases where the shear is concentrated well away from the arcade axis, such that Bz, the component of field parallel to the axis, increases outward to produce an inward Bz2/8 pi magnetic pressure gradient force. These results contrast with an earlier claim, shown to be incorrect, that field lines can sometimes become depressed as a result of shear. We conjecture that an inflation of the entire field will always result from the shearing of simple arcade configurations. These results have implications for prominence formation, the interplanetary magnetic flux, and possibly also coronal holes.

27016 (AD-A–216325/1/XAB) **Study of the evolution of solar-active regions for improving solar-flare forecasts.** Bornmann, P.L.; Kalmbach, D.; Kulhanek, D.; Casale, A. Colorado Univ., Boulder, CO (USA). Cooperative Inst. for Research in Environmental Sciences. 20 Dec 1989. 9p. Available from NTIS, PC A02/MF A01.

Statistics on the frequency of transition between active region classes were calculated and used to derive the expected rate of flaring for the next 2-7 days. Five years of McIntosh active region classifications were analyzed using the newly-developed software called TELSAR (Tracking and EvoLution of Solar Active Regions). The most frequent transitions between these 63 different classes usually involve a single-step change in one of the three classification parameters. The evolution of the classes and the average, single-day flare rate were used to predict flare rates for each class over the next several days. For flares of X-ray class M, these rates can differ from persistence predictions by more than 0.5 flares per day, although a more typical difference is 0.1 flares per day. The rarity of some classes suggests that merging these classes with others may improve flare statistics and thereby improve flare forecasts.

27017 (AD-A–216380/6/XAB) **Detecting extended solar-system structures with COBE (Cosmic Background Explorer).** Sykes, M.V. Steward Observatory, Tucson, AZ (USA). 29 Nov 1989. 17p. (SCIENTIFIC–4). Available from NTIS, PC A03/MF A01.

The Cosmic Background Explorer (COBE) offers a new opportunity for the study of extended solar system structures discovered by the Infrared Astronomical Satellite (IRAS). It is expected that of these structures, Type II dust trails may be detected by the Diffuse Infrared Background Experiment (DIRBE) in which case there will be a final chance to discover their parent sources, which are as yet unknown, by immediate follow-up from groundbased imaging along the trail. Zodiacal dust bands will be easily detected at most wavelengths by DIRBE, allowing for additional analysis of their structure and geometry, as well as comparison at near-infrared wavelengths with the spectra of asteroid family members from which they are thought to derive. The other COBE experiments, as a consequence of their large beam sizes and long operating wavelengths, are not expected generally to detect these structures in the broad zodiacal emission.

27018 (IC–89/362) **Workshop on relativistic astrophysics.** Abramowicz, M.A. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 7p. Order Number DE90622483. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A Chairman's report on the workshop on Relativistic Astrophysics, Boulder, Colorado, 3-7 July 1989.

The consequences of the discovery of a half-millisecond pulsar in the Supernova SN 1987A, the problem of test particle motion in a given gravitational field and problems connected with the gravitational radiation are discussed. 10 refs, 2 figs.

27019 (LA-UR–90-874) **Recent advances in the studies of the nova outburst.** Starrfield, S. (Los Alamos National Lab., NM (USA)). Los Alamos National Lab., NM (USA). [1989]. 5p. Sponsored by National Aeronautics and Space Administration. DOE Contract W-7405-ENG-36. (CONF-8910381–1: 11. North American workshop on CV's and LMXRE's, Santa Fe, NM (USA), 9-13 Oct 1989). Order Number DE90008936. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This conference marks 13 years since the first North American Cataclysmic Variable workshop (NACVW) was held in 1976 at the University of Illinois. It, therefore, seems appropriate to briefly review the progress that we have made in understanding the nova outburst. Recent detailed reviews of both the nova binary systems and their outbursts can be found in the proceedings of the Madrid IAU Symposium No. 122 on the "Physics of Classical Novae" (Cassatella and Viotti 1990), Gehrz (1988), Shara (1989), Starrfield (1988, 1989), and Bode and Evans (1989). Because of the

existence of these reviews, I will describe only a few of the developments that have had a major impact on studies of the outburst. 19 refs.

27020 (LA-UR–90-875) **The 1989 outburst of V404 Cygni: A very unusual x-ray nova.** Wagner, R.M. (Ohio State Univ., Columbus, OH (USA). Dept. of Astronomy); Collins, G.W.; Bertram, R.; Starrfield, S.; Cassatella, A.; Gonzalez-Riestra, R.; Shrader, C.; Sonneborn, G.; Kreidl, T.J.; Howell, S.B. Los Alamos National Lab., NM (USA). [1989]. 6p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8906225–4: Physics of classical novae: IAU colloquium no. 122, Madrid (Spain), 27-30 Jun 1989). Order Number DE90008935. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

On May 22, 1989, the Japanese Ginga Team discovered a new x-ray source that was cataloged as GS 2023+338. This source was subsequently identified as coincident in position with a previously known nova cataloged as V404 Cygni. Its last recorded outburst was in 1938 when it rose to about 12th mag. Spectroscopic data were obtained and confirmed the nature of the outburst. Additional ground based data were obtained by us at CTIO and the VLA. The x-ray behavior of this object has been reported to be very unusual and it reached a peak of about 17 crab about one week after discovery. Since then it has varied widely in magnitude at all wavelengths at which it has been studied. We present a brief summary of the observations that have been obtained up to the time of the meeting and shortly thereafter. 5 refs., 3 figs.

27021 (LA-UR–90-1037) **Substorms: Their expansion and recovery phases.** Hones, E.W. Los Alamos National Lab., NM (USA). [1990]. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-9003131–1: Workshop on magnetospheric substroms and solar flares, Honolulu, HI (USA), 26-30 Mar 1990). Order Number DE90008970. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Solar flares and magnetospheric substorms are each presumably processes by which energy is released from storage in magnetic fields and converted into kinetic energy of plasma and energetic particles. There are a number of analogies between flares and substorms. This paper briefly discusses substorms, their expansion and recovery phases, and a model by which they are presently explained. Two features of substorms, the "retreating neutral line" and the "separatrix layer" are offered as features which might have identifiable (observable?) analogies in flares. 13 refs., 11 figs.

27022 **Physics and astrophysics from a lunar base.** AIP Conference Proceedings 202. Potter, A.E.; Wilson, T.L. (eds.). 341p. American Institute of Physics, New York, NY (US) (1990). Sponsored by American Institute of Physics. (CONF-8905272–: NASA workshop on physics from a lunar base, Stanford, CA (USA), 19 May 1989).

This report contains papers on physics and astrophysic preformed on the moon. The general topics of discussion are: space physics; cosmic ray physics; neutrino physics; gravitation and general relativity; gravitational radiation physics; cosmic background radiation physics; particle astrophysics; gamma-ray and x-ray physics; and surfaces physics. (LSP)

27023 **The shocking development of lithium (and boron) in supernovae.** Dearborn, D.S.P. (Lawrence Livermore National Lab., CA (USA)); Schramm, D.N.; Steigman, G.; Truran, J. *Astrophysical Journal (USA),* 347: 455-460 (Dec 1989).

It is shown that significant amounts of Li-7 and B-11 are produced in Type 2 supernovae. The synthesis of these rare elements occurs as the supernova shock traverses the base of the hydrogen envelope burning He-3 to masses 7 and 11 via alpha capture. The yields in this process are sufficient to account for the difference in lithium abundance observed between Pop 2 and Pop 1 stars. Since lithium (and boron) would, in this manner, be created in the same stars that produce the bulk of the heavy elements, the lithium abundance even in old Pop 1 stars would be high (as observed). The B-11 production may remedy the long-standing problem of the traditional spallation scenario to account for the observed isotopic ratio of boron. Observational consequences of this mechanism are discussed, including the evolution of lithium and boron isotope ratios in the Galaxy and the possible use of the boron yields to constrain the number of blue progenitor Type 2 supernovae. 40 refs.

27024 **Cosmions and the stability of the solar core.** Raby, S. (Los Alamos National Lab., NM (USA)). *Astrophysical Journal (USA),* 347: 551-560 (Dec 1989).

It is assumed that cosmions, a species of weakly interacting massive particles, are present in the sun and dominate the thermal transport in the core. The central temperature of the sun is lowered and the core is isothermal out to a mass fraction of order 0.05. As a consequence of the reduced core temperature, the solar neutrino problem is solved. In this paper, a set of linear stability equations valid for the solar core is derived in this context. A thermal instability in the solar core is found with a time scale typically on the order of a million years, but it could be as long as 100 million years. 36 refs.

27025 **Unitarity limits on the mass and radius of dark-matter particles.** Griest, K. (Center for Particle Astrophysics, University of California, Berkeley, California 94720 (USA)); Kamionkowski, M. *Physical Review Letters (USA),* 64(6): 615-618 (5 Feb 1990).

Using partial-wave unitarity and the observed density of the Universe, we show that a stable elementary particle which was once in thermal equilibrium cannot have a mass greater than 340 TeV. An extended object which was once in thermal equilibrium cannot have a radius less than 7.5×10^{-7} fm. A lower limit to the relic abundance of such particles is also found.

27026 **Interstellar polycyclic aromatic hydrocarbons - The infrared emission bands, the excitation/emission mechanism, and the astrophysical implications.** Allamandola, L.J. (NASA, Ames Research Center, Moffett Field, CA (USA)); Tielens, G.G.M.; Barker, J.R. *Astrophysical Journal, Supplement Series (USA),* 71: 733-775 (Dec 1989).

A comprehensive study of the PAH hypothesis is presented, including the interstellar, IR spectral features which have been attributed to emission from highly vibrationally excited PAHs. Spectroscopic and IR emission features are discussed in detail. A method for calculating the IR fluorescence spectrum from a vibrationally excited molecule is described. Analysis of interstellar spectrum suggests that the PAHs which dominate the IR spectra contain between 20 and 40 C atoms. The results are compared with results from a thermal approximation. It is found that, for high levels of vibrational excitation and emission from low-frequency modes, the two methods produce similar results. Also, consideration is given to the relationship between PAH molecules and amorphous C particles, the most likely interstellar PAH molecular structures, the spectroscopic structure produced by PAHs and PAH-related materials in the UV portion of the interstellar extinction curve, and the influence of PAH charge on the UV, visible, and IR regions. 229 refs.

27027 **Shock-generated X-ray emission in radiatively driven winds - A model for Tau Scorpii.** Macfarlane, J.J. (Wisconsin Univ., Madison (USA)); Cassinelli, J.P. *Astrophysical Journal (USA),* 347: 1090-1099 (Dec 1989).

A one-dimensional radiation-hydrodynamics code is used to numerically investigate the structure and evolution of shocks in the winds of hot stars. Results are presented for the specific case of Tau Sco, a well-studied main-sequence B star for which there are X-ray data from the Einstien satellite's Solid State Spectrometer. A phenomenological radiative acceleration term and a mass-loss rate consistent with UV observations, are used to determine the time dependence of the temperatures within and X-ray emission from an isolated shock region. The driving acceleration leads to the formation of a two-component shock zone with forward and reverse shocks, each with their own characteristic temperature. A denser cold region forms between the two shocks, which could potentially account for the presence of narrow absorption features that are observed in the UV P Cygni profiles of many hot stars. The X-ray emission spectra from the shocks in the calculations are in good general agreement with two-temperature model fits to Einstein X-ray observations. 44 refs.

6402 Atmospheric Physics

27028 (AD-A–215953/1/XAB) **Development and use of data-analysis procedures for the CRRES (Combined Release and Radiation Effects Satellite) payloads AFGL-701-2/Dosimeter and AFGL-701-4/Fluxmeter and application of the data analysis results to improve the static and dynamic models of the earth's radiation belts. Scientific report No. 1.** Dichter, B.K.; Hanser, F.A. Panametrics, Inc., Waltham, MA (USA). 2 Oct 1989. 16p. Available from NTIS, PC A03/MF A01.

The Earth's magnetospheric radiation environment is a major hazard for spaceborne electronic systems. This report documents work aimed at providing the U.S. Air Force with accurate, time dependent radiation belt and cosmic ray environmental specifications. The data for this effort is obtained from two instruments to be flown aboard the Combined Release and Radiation Satellite (CRRES). These instruments are the Energetic Particle Dosimeter and the High Energy Fluxmeter.

27029 (AD-A–216256/8/XAB) **Particle simulations in magnetospheric plasmas. Final technical report, 15 November 1988-14 November 1989.** Nishikawa, K.I. Iowa Univ., Iowa City, IA (USA). Dept. of Physics and Astronomy. 18 Dec 1989. 12p. Available from NTIS, PC A03/MF A01.

Contents: simulation study of a new mechanism for excitation of kinetic waves in a magnetoplasma; beam instability in the foreshock; whistler mode driven by the spacelab 2 electron beam; simulation of electron cyclotron harmonic waves by ampte lithium release.

27030 (AD-A–216260/0/XAB) **Ionospheric heating with oblique waves. Volume 1. Electron density perturbations. Technical report, 13 February 1987-31 August 1988.** Fields, E.C.; Bloom, R.M.; Heikes, K.E. Pacific-Sierra Research Corp., Los Angeles, CA (USA). Sep 1988. 63p. (PSR–1864). Available from NTIS, PC A04/MF A01.

The transport and chemical equations that described electron density and temperature changes produced by electric fields in the ionosphere are derived and cast into a form suitable for numerical integration. By using those equations in conjunction with previously developed methods for calculating electric fields near caustics, the density and temperature changes produced by an oblique ionospheric high-frequency heater can be computed straightforwardly. The necessary inputs are: (1) heater power, (2) heater radiation pattern, (3) heater frequency, and (4) model ionosphere. Analytical solutions for idealized heater beamshapes indicate that heat conduction and diffusion are also presented.

27031 (PB–90-148669/XAB) **Solar-Geophysical Data Number 542, October 1989. Part 1 (prompt reports). Data for September, August 1989, and late data.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). Oct 1989. 177p. (SGD–542-PT-1). Available from NTIS, PC A09/MF A01.

See also Part 2, PB–90-148677.

Contents: detailed index for 1989; data for September 1989 – solar-terrestrial environment, IUWDS alert periods (advance and worldwide), solar activity indices, solar flares, solar radio emission, stanford mean solar magnetic field; data for August 1989 – solar active regions, sudden ionospheric disturbances, solar radio spectral observations, cosmic ray measurements by neutron monitor, geomagnetic indices; late data – cosmic ray measurements by neutron monitor Huancayo June 1989, inferred interplanetary magnetic field 1984-1988, geomagnetic activity indices July 1989.

27032 (RAL–89-111) **Auroral electron acceleration.** Bryant, D.A. Rutherford Appleton Lab., Chilton (UK). Oct 1989. 59p. (CONF-8905232–: 4. workshop on perspectives in nuclear physics at intermediate energies, Trieste (Italy), 8-12 May 1989). Order Number DE90619482. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

To be published in Physica Scripta.

Two theories of auroral electron acceleration are discussed. Part 1 examines the currently widely held view that the acceleration is an ordered process in a quasi-static electric field. It is suggested that, although there are many factors seeming to support this theory, the major qualifications and uncertainties that have been identified combine to cast serious doubt over its validity. Part 2 is devoted to a relatively new interpretation in terms of stochastic acceleration in turbulent electric fields. This second theory, which appears to account readily for most known features of the electron distribution function, is considered to provide a more promising approach to this central question in magnetospheric plasma physics. (author).

6403 Atomic, Molecular, and Chemical Physics

Refer also to citation(s) 26285, 26286, 26287, 26289, 26291, 26292, 26295, 26296, 26348, 26441, 26497, 26511, 27098, 27211, 27255, 27257

27033 (BNL–44331) **Supercontinuum generation in gases: A high order nonlinear optics phenomenon.** Corkum, P.B. (National Research Council of Canada, Ottawa, ON (Canada)); Rolland, C.; Srinivasan-Rao, T. Brookhaven National Lab., Upton, NY (USA). [1986]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-860673–1: 5. topical meeting on ultrafast phenomena, Snowmass, CO (USA), 16-19 Jun 1986). Order Number DE90008819. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The recent development of high power, ultrashort pulse sources has created renewed interest in the interaction between intense laser radiation and free atoms and molecules. Not only is it feasible to apply laser fields that approach, or exceed, the strength of the atomic field as seen by the outer electrons, but it is also possible to apply these fields nonadiabatically using ultrashort pulses. Until now, experiments have been restricted to isolated atoms. However, because the theories of nonlinear optics and multiphoton ionization are so interrelated, we should expect these new phenomena to have optical signatures. In addition to their intrinsic interest, nonlinear optics experiments can add a new perspective for judging emerging theories of high intensity laser processes. Clearly, there is a new class of experiments to be performed using ultrahigh power, ultrashort pulses. We describe an experiment performed in high pressure gases with a 2 psec or 70 fsec 0.6 μm pulse focused to a peak intensity of $I \lesssim 10^{13}$ W/cm^2. The maximum intensity exceeds that in which multiphoton ionization is observed in longer pulse experiments in Xe using either 1.06 μm or 0.53 μm radiation. It is approximately the intensity at which tunnel ionization is observed with nanosecond 10 μm pulses in very low pressure Xe. Furthermore, at such intensities in 0.53 μm and 1.06 μm experiments, high energy electrons are observed from Xe.

27034 (DOE/ER/13549–4) **[Electron transfer, ionization, and excitation in atomic collisions]: Progress report.** Winter, T.G. Pennsylvania State Univ., University Park, PA (USA). 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13549. Order Number DE90009754. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This report discusses theoretical work on electron transfer, ionization and excitation in atomic collisions. (LSP)

27035 (IC–89/309) **Sub-Poissonian photon statistics in time-dependent collective resonance fluorescence.** Buzek, V.; Tran Quang; Lan, L.H. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 14p. Order Number DE90622297. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We have discussed the photon statistics of the spectral components of N-atom time-dependent resonance fluorescence. It is shown that in contrast to the stationary limit, sub-Poissonian photon statistics in the sidebands occur for any number N of atoms including the case $N >> 1$. Reduction in Maldel's parameters $Q_{\pm 1}$ is found with increasing numbers of atoms. The typical time for the presence of sub-Poissonian statistics is proportional to 1/N. (author). 31 refs, 1 fig.

27036 (IC–89/346) **Information entropy and Thomas-Fermi screening functions.** Donnamaria, M.C. (Comision Nacional de Investigaciones Espaciales, Vicente Lopez (Argentina). Lab. de Fisica); Meson, A.M.; Proto, A.N. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 23p. Order Number DE90622298. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this work we apply the information entropy concept to analyze different trial electron densities in momentum and coordinate spaces, into the Thomas-Fermi density functional formalism. Furthermore, we try to assess how well-known physical properties of neutral atoms are reproduced and hence evaluate the quality of the screening functions in the light of their predictive capacity. (author). 32 refs, 4 figs, 3 tabs.

27037 (IC–89/350) **Multifractal analysis of electronic transitions in a family of quasiperiodic potentials.** Thakur, P.K.; Brouers, F.; Ananthakrishna, G. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 18p. Order Number DE90622299. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We analyze the nature of extended, localized and critical states in an extension of the Aubry model where mobility edges have been reported. We calculate the multifractal spectra of exact eigenstates of this model for varying chain lengths and confirm the existence of mobility edges. Moreover we are able to show that the localized states can exhibit a behaviour rather different from the usual exponentially decaying states in a random potential. Lyapounov exponents or participation ratios are unable to produce such information. Our results also indicate that a stable multifractal distribution is a general feature of crossovers of states of different nature. This conjecture should be confirmed in other models. (author). 17 refs, 8 figs.

27038 (IC–89/387) **The polaron effects and relaxation of nonequilibrium electrons in the quasi-two-dimensional systems.** Guseinov, N.M. (International Centre for Theoretical Physics, Trieste (Italy)); Rustamov, K.A.; Seyid-Rzayeva, S.M. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 19p. Order Number DE90622300. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The problem on weak-coupling polaron in the quasi-two-dimensional electron system is solved. Analytical expressions for polaron energy shift of the subband and polaron contribution to the effective electron mass with the arbitrary quantum well width are found. The expressions obtained give well-known values for two- and three-dimensional limit cases. The comparison of polaron contribution to the mass with the available experimental data is carried out. Energy relaxation processes of nonequilibrium quasi-two-dimensional electrons with the optic phonon emission are also considered. General analytical expressions for the frequencies of intra-subband and inter-subband transitions for the threshold electron energy are obtained. (author). 12 refs, 4 figs.

27039 (KAERI/RR–729/88) **Studies on laser atomic spectroscopy.** Lee, Jong Min (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Ohr, Young Gie; Cha, Hyung Ki; Baik, Dae Hyun; Kim, Jung Bog; Jeong, Do Young; Cha, Byung Heon; Lim, Chang Hwan; Yi, Jong Hoon; Kim, Cheol Jung. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 248p. (In Korean). Order Number DE90622301. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Laser atomic spectroscopy is studied both theoretically and experimentally. For Na-like ions, possible electric dipole, quadrupole and magnetic dipole transitions between atomic levels below 4f doublet F (J=7/2) state are investigated, using the recently developed computer programs - MCDF, MJE and MULTPOL. Line strength, oscillator strength and transition probability are calculated. A preliminary results for Hg-RIS experiment are also presented. Q-switched Nd:YAG laser, high power dye laser, vacuum system, ionization cell and ion measuring system are constructed, and their characteristics are examined. (Author).

27040 (LRP–386/89, pp. 2) **A novel electron beam diagnostic using the measurement of the cyclotron emission (ECE).** Alberti, S. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Tran, M.Q.; Tran, T.M.; Hogge, J.P.; Muggli, P.; Isaak, B. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). Oct 1989. (CONF-8910353–: 14. international conference on infrared and millimeter waves, Wuerzburg (Germany, F.R.), 2 Oct 1989). In *Invited and contributed papers presented at the 14. International conference on infrared and millimeter waves.* Order Number DE90706060. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A new method for the measurement of the parallel momentum distribution function of a monoenergetic magnetized weakly relativistic electron beam is presented. A gyrating electron having a parallel velocity β emits a radiation at a doppler shifted frequency given by $\omega=\omega_0(1-\beta\cos\theta)^{-1}$ were θ is the observation angle and $\omega_0=qB/m$. Therefore, at a given θ, the measurement of the emitted spectrum of an electron beam gives, in a straightforward manner, the distribution function β. In our analysis we take into account relativistic effects on the angular distribution of the emission as well as the experimental constraints such as the angular dependency of the gain of the antenna used for the detection. Experimental results will be presented for a 70 keV annular electron beam. (author) 5 figs., 1 ref.

27041 **Nonequilibrium thermodynamic models and applications to hydrogen plasma.** Cho, K.Y. Thesis (Ph. D.). 195p. Georgia Institute of Technology, Atlanta, GA (US) (1988). Available from University Microfilms, PO Box 1764, Ann Arbor, MI 48106, Order No.89-04,805.

A generalized multithermal equilibrium (GMTE) thermodynamic model is developed and presented with applications to hydrogen. A new chemical equilibrium equation for GMTE is obtained without the ensemble temperature concept, used by a previous MTE model. The effects of the GMTE model on the derivation and calculation of the thermodynamic, transport, and radiative properties are presented and significant differences from local thermal equilibrium (LTE) and two temperature model are discussed. When the electron translational temperature (T_e) is higher than the translational temperature of the heavy particles, the effects of hydrogen molecular species to the properties are significant at high T_e compared with LTE results. The density variations of minor species are orders of magnitude with kinetic nonequilibrium at a constant electron temperature. A collisional-radiative model is also developed with the GMTE chemical equilibrium equation to study the effects of radiative transfer and the ambipolar diffusion on the population distribution of the excited atoms. The nonlocal radiative transfer effect is parameterized by an absorption factor, which is defined as a ratio of the absorbed intensity to the spontaneous emission coefficient.

27042 **Dielectronic recombination on heliumlike argon.** Ali, R. (J. R. Macdonald Laboratory, Physics Department, Kansas State University, Manhattan, Kansas 66506 (USA)); Bhalla, C.P.; Cocke, C.L.; Stockli, M. *Physical Review Letters (USA)*, 64(6): 633-636 (5 Feb 1990).

We have used the electron-energy dependence of yields of heliumlike and lithiumlike argon ions from the Kansas State University electron-beam ions source (EBIS) to measure the ratio of the cross section for Δn=1 dielectronic recombination of heliumlike argon to that for electron ionization of lithiumlike argon. By normalizing to the latter cross section we obtain absolute dielectronic recombination cross sections and find good agreement with theoretical calculations for the lower-energy resonances.

27043 **Factors affecting emittance measurements of ion beams.** Tsai, C.C. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-8071 (USA)); Akerman, M.A.; Becraft, W.R.; Dagenhart, W.K.; Haselton, H.H.; Schechter, D.E.; Stirling, W.L.; Whealton, J.H.; Donaghy, J.J. *Review of Scientific Instruments (USA)*, 61(2): 783-787 (Feb 1990).

The emittances of hydrogen and deuterium negative ion beams produced by volume ion sources have been measured in a transverse plane normal to the beam trajectory. The extraction voltage was varied from 10 to 40 kV, and the transverse magnetic field in the Penning discharges was varied from 0.1 to 0.2 T. Measurements were made on beams with current densities up to 60 mA/cm^2 at Oak Ridge National Laboratory with an emittance scanner originally developed at Los Alamos National Laboratory. The beam profile at the scanner can be used to improve the accuracy of the emittance measurements. Other factors affecting emittance measurements are discussed. This analysis may be applicable to other ion sources.

27044 Solid state cesium ion guns for surface studies. Souzis, A.E. (Physics and Engineering Physics Department, Stevens Institute of Technology, Hoboken, New Jersey 07030 (US)); Carr, W.E.; Kim, S.I.; Seidl, M. *Review of Scientific Instruments (USA),* 61(2): 788-792 (Feb 1990).

Three cesium ion guns covering the energy range of 5–5000 V are described. These guns use a novel source of cesium ions that combine the advantages of porous metal ionizers with those of aluminosilicate emitters. Cesium ions are chemically stored in a solid electrolyte pellet and are thermionically emitted from a porous thin film of tungsten at the surface. Cesium supply to the emitting surface is controlled by applying a bias across the pellet. A total charge of 10.0 C can be extracted, corresponding to greater than 2000 h of lifetime with an extraction current of 1.0 μA. This source is compact, stable, and easy to use, and produces a beam with >99.5% purity. It requires none of the differential pumping or associated hardware necessary in designs using cesium vapor and porous tungsten ionizers. It has been used in ultrahigh-vacuum (UHV) experiments at pressures of $<10^{-10}$ Torr with no significant gas load. Three different types of extraction optics are used depending on the energy range desired. For low-energy deposition, a simple space-charge-limited planar diode with a perveance of 1×10^{-7} A/V$^{3/2}$ is used. Current densities of 10.0 μA/cm^2 at the exit aperture for energies $\lesssim$20 V are typical. This type of source provides an alternative to vapor deposition with the advantage of precise flux calibration by integration of the ion current. For energies from 50 to 500 V and typical beam radii of 0.5 to 0.2 mm, a high perveance Pierce-type ion gun is used. This gun was designed with a perveance of 1×10^{-9} A/V$^{3/2}$ and produces a beam with an effective temperature of 0.35 eV. For the energy range of 0.5 to 5 keV, the Pierce gun is used in conjunction with two Einzel lenses, enabling a large range of imaging ratios to be obtained. Beam radii of 60 to 300 μm are typical for beam currents of 50 nA to 1.0 μA.

27045 Synthesis of monotritiomethyl iodide from thioethers. Hydrogenolysis in the presence of thioethers. Saljoughian, M. (Lawrence Berkeley Lab., CA (USA)); Morimoto, H.; Rapoport, H. *Journal of Organic Chemistry (USA),* 54(19): 4689-4691 (15 Sep 1989). DOE Contract AC03-76SF00098.

Monotritiomethyl iodide with high specific activity is a valuable reagent for the incorporation of a tritiated methyl group and has attracted much attention in recent years. The reagent can be used for specific tritium labeling of amines, alcohols, and thiols and for C-methylation of peptidic amino acid residues. We recently reported a new procedure for the synthesis of monotritiomethyl iodide by the preparation of chloromethyl esters, followed by tritiodehalogenation with carrier free tritium gas and subsequent cleavage of the [^{3}H$_1$] ester by lithium iodide. Due to the time necessary for C-Cl bond hydrogenolysis in these esters (normally 12 h), we observed significant isotopic dilution, and the theoretical specific activity was not attainable. Also, in most cases, only 75-80% of the precursor's specific activity could be preserved in the N-methylated products. To overcome these deficiencies, we have continued our investigations and now report a procedure that effectively proceeds with rapid tritium incorporation and essentially no isotope dilution.

6404 Fluid Physics

27046 (AD-A-216301/2/XAB) **Electron production, electron attachment, and charge recombination process in high pressure gas discharges. Final report, 1 August 1986-31 July 1989.** Lee, L.C. San Diego State Univ., CA (USA). Dept. of Electrical and Computer Engineering. 25 Sep 1989. 67p. Available from NTIS, PC A04/MF A01.

Electron transport parameters for gaseous mixtures containing electro-negative gases in buffer gases were investigated in this research program. Absolute electron attachment rate constants and cross sections of halogen compounds were measured. Photodetachment cross sections of halogen negative ions in discharge media were determined. Discharge current switching induced by laser irradiation of discharge media was observed. These basic data are obtained for the development of various gaseous discharge switches and for the study of basic discharge phenomena as well. High repetition-rate discharge switches, opening switches, and radiation or e-beam controlled switches are needed for the development of high power lasers, fusion experiments, magnetic energy storage systems, and particle beam experiments. High pressure gaseous discharges could be used for the development of these switches. The measured electron transport parameters are needed for determining the rise and decay times of discharge pulses, discharge stability, discharge uniformity, and current density.

27047 (AD-A-216408/5/XAB) **Specialized instrumentation for computational fluid-dynamics research. Final report, 1 July 1983-30 June 1984.** Rubin, S.G. Cincinnati Univ., OH (USA). Dept. of Aerospace Engineering and Engineering Mechanics. 27 Aug 1984. 3p. Available from NTIS, PC A01/MF A01.

Pub. in Computer Design, 245(Jul 1984).

A CSPI MAP 6420 array processor and auxilliary memory, hardware and software has been used to develop a FORTRAN-based software package to facilitate user communication between the PRIME 650 host and the array processor. The 6420 system consists of a 5 MFLOP arithmetic processor with a parallel processing IPU for rapid address generation and 4 megabytes of central memory. The operating system (SNAP-III) provides control and communication between the host FORTRAN applications program and the system software. Complete control is accomplished by the insertion of FORTRAN-like commands directly into the user's FORTRAN program. The 6420 can operate in two separate programming modes: (1) as a conventional array processor, (2) as a FORTRAN-subroutine peripheral processor. The latter node can be immediately utilized by those researchers who have little or no familiarity with array processors and their use. The full capability of the array processor (mode (1)) will be utilized for vectorization of algorithms and improvement of overall computational efficiency.

27048 Temporal evolution of collisionless sheaths. Cho, M.H. Thesis (Ph. D.). 143p. Univ. of Wisconsin, Madison, WI (US) (1988). Available from University Microfilms, PO Box 1764, Ann Arbor, MI 48106, Order No.89-01,156.

An experimental study was performed to determine the temporal evolution of Langmuir sheaths near an electrode to which a negative step bias is applied in a collisionless argon plasma. The plasma was produced by a hot-filament discharge in a multi-dipole device, with typical plasma parameters of $P_0 \sim 1 \times 10^{-4}$ Torr (argon), $n_e \sim 1 \times 10^9$ cm^{-3}, $T_e \sim 3$ eV, and $T_i \sim 0.2$ eV. Plasma potential data were obtained using emissive probes with two different techniques - time-resolved sampling and time-averaged techniques. The sheath is found initially to form close to the electrode, to extend to a maximum separation approximately with the speed of ion-acoustic wave, and to contract rather slowly to a steady-state value. The time scale required to reach a steady state is found to be close to the time scale of the presheath relaxation, which scales approximately as the plasma dimension divided by the ion-acoustic speed in the plasma. Characteristics of sheaths in rf plasmas are also measured using a parallel plate plasma capacitor placed in the multi-dipole device. It is observed that the plasma potential profile has significant variation with frequency, even for frequencies as low as 1 kHz which are far below the ion plasma frequency ($\sim$ 1 MHz).

27049 Algebraic instability of hollow electron columns and cylindrical vortices. Smith, R.A. (Department of Physics, B-019, University of California, San Diego, La Jolla, California 92093 (USA)); Rosenbluth, M.N. *Physical Review Letters (USA),* 64(6): 649-652 (5 Feb 1990).

An axisymmetric, amgnetically confined electron column, in which the $\mathbf{E}\times\mathbf{B}$ rotation frequency is not a monotone function of radius, is linearly unstable to two-dimensional, electrostatic disturbances with azimuthal mode number l=1. The perturbation density is asymptotically proportional to $\sqrt{t}$ and may be described as a shift of the core of the column. A particle-in-cell simulation indicates that harmonics grow rapidly and that there are secondary instabilities. An identical instability arises in hollow circular vortex columns in an inviscid, incompressible neutral fluid.

6450 High Energy Physics

Refer also to citation(s) 27022, 27361

27050 (DOE/ER/40214–3) **[Research in theoretical particle physics]: Technical progress report, December 1988–December 1989.** Kansas Univ., Lawrence, KS (USA). Dept. of Physics and Astronomy. [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER40214. Order Number DE90009751. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the following topics: effective actions and the S-matrix for a bound states; neutrino astrophysics; color transparency and nuclear target effects in hadron scattering; neutrino dark matter and galactic dynamics; Berry's phase and symplectic structure; and Bosonization and the meaning of equivalence.

27051 (ENEA-RT-TIB–89-41) **OMICRON: An executive code for LLNL evaluated charged-particle library (ECPL).** Mengoni, A.; Panini, G.C. ENEA, Bologna (Italy). Dipt. Tecnologie Intersettoriali di Base. Oct 1989. 40p. (RT/TIB–89-41). Order Number DE90764313. Available from NTIS (US Sales Only), PC A03/MF A01.

An executive code OMICRON, which translates into the ENDF/B format, and produces plots and listings of the data contained in the Evaluated Charged-Particle Library (ECPL) of the Lawrence Livermore Evalutated Nuclear Data Libraries (ENDL), is presented altogether with a brief description of ECPL.

6451 Particle Interactions and Properties - Experimental

Refer also to citation(s) 26495, 27195

27052 (BONN-ME–89-09) **The study of baryon resonances by real photons.** Anton, G. Bonn Univ. (Germany, F.R.). Physikalisches Inst. Dec 1989. 20p. (CONF-8907150–: 12. course of the International School of Nuclear Physics: the nature of hadrons and nuclei studied by electron scattering, Erice (Italy), 16-25 Jul 1989). Available from Bonn Univ. (Germany, F.R.). Physikalisches Inst. Available from Bonn Univ. (Germany, F.R.). Physikalisches Inst.

The experimental status of baryon resonances is reviewed. Different reaction channels and the extraction of baryon resonance parameters are discussed. For single pion photoproduction the contribution of different observables are shown pointing out the importance of polarization observables. The η-cusp is described as an example of a threshold effect. Experimental techniques in connection with a tagged photon beam are surveyed. As examples new experiments at the stretcher accelerator ELSA in Bonn are briefly discussed. (orig.).

27053 (DOE/ER–3072-54) **Physics at the Planck scale: Tests of CPT invariance at the Fermilab main injector.** Gollin, G.D. (Princeton Univ., NJ (USA). Dept. of Physics); Meyers, P.D.; Tschirhart, R. Illinois Univ., Urbana, IL (USA). Dept. of Physics. [1989]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER01195. (UIUC-HEPG–90-39;CONF-8905183–5: Workshop on physics at the main injector, Batavia, IL (USA), 16-18 May 1989). Order Number DE90008865. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

It is possible that CPT-violating amplitudes with sizes of order m_K/m_{Planck} contribute to processes involving K mesons. We describe several tests of CPT invariance that could be carried out at the Fermilab Main Injector. To our surprise we find that one experiment, a precision measurement of the CP-violating charge asymmetry in semileptonic K decays, can be performed with sufficient statistical accuracy to detect the presence of CP^T-violating amplitudes of size m_K/m_{Planck} which generate a mass difference between K^0 and $\bar{K}^0$. 10 refs.

27054 (FNAL/C–90/20) **Neural networks for triggering.** Denby, B. (Fermi National Accelerator Lab., Batavia, IL (USA)); Campbell, M.; Bedeschi, F.; Chriss, N.; Bowers, C.; Nesti, F. Fermi National Accelerator Lab., Batavia, IL (USA). Jan 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-900143–32: Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium, San Francisco, CA (USA), 15-19 Jan 1990). Order Number DE90009076. Available from NTIS, PC A02/MF A01; OSTI; INIS.

Two types of neural network beauty trigger architectures, based on identification of electrons in jets and recognition of secondary vertices, have been simulated in the environment of the Fermilab CDF experiment. The efficiencies for B's and rejection of background obtained are encouraging. If hardware tests are successful, the electron identification architecture will be tested in the 1991 run of CDF. 10 refs., 5 figs., 1 tab.

27055 (FNAL/C–90/37) **Fixed target electroweak and hard scattering physics.** Brock, R. (Michigan State Univ., East Lansing, MI (USA)); Brown, C.N.; Montgomery, H.E.; Corcoran, M.D. (eds.). Fermi National Accelerator Lab., Batavia, IL (USA). Feb 1990. 59p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-890872–9: Workshop on physics at Fermilab in the 1990's, Breckenridge, CO (USA), 15-24 Aug 1989). Order Number DE90009079. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

The possibilities for future physics and experiments involving weak and electromagnetic interactions, neutrino oscillations, general hard scattering and experiments involving nuclear targets were explored. The studies were limited to the physics accessible using fixed target experimentation. While some of the avenues explored turn out to be relatively unrewarding in the light of competition elsewhere in the world, there are a number of positive conclusions reached about experimentation in the energy range available to the Main Injector and Tevatron. Some of the experiments would benefit from the increased intensity available from the Tevatron utilizing the Main Injector, while some require this increase. Finally, some of the experiments would use the Main Injector low energy, high intensity extracted beams directly. A program of electroweak and hard scattering experiments at fixed target energies retains the potential for important contributions to physics. The key to major parts of this program would appear to be the existence of the Main Injector. 115 refs, 17 figs.

27056 (LA-UR–90-1014) **A measurement of the gravitational acceleration of the antiproton.** Holzscheiter, M.H. Los Alamos National Lab., NM (USA). [1990]. 6p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900183–3: Recontres De Moriond '90: new and exotic phenomena, Les Arcs (France), 20-27 Jan 1990). Order Number DE90008903. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A fundamental experiment in gravity proposed by us, is the measurement of the gravitational force on antimatter. This measurement would constitute the first direct test of the Weak Equivalence Principle (WEP) for antimatter. The availability of low-energy antiprotons at CERN has made such an experiment feasible, and a proposal to carry out such a measurement has been accepted by the CERN Program Committee. We plan to use a time-of-flight technique similar to that pioneered by Fairbank and Witteborn in their measurement of the gravitational force on an electron. Very slow particles are launched into a vertical drift tube and the time-of-flight spectrum of these particles is recorded. This spectrum will exhibit a cut-off point directly related to the gravitational acceleration of the particles. Obtaining very slow antiprotons involves several stages of deceleration. Antiprotons from LEAR will be initially decelerated from 2 MeV to tens of kilovolts by passing them through a thin foil. After capture and cooling in a series of ion traps, the antiprotons will be in a thermal distribution with a temperature of a few degrees Kelvin. These ultra-cold antiprotons will then be released a few at a time into the drift tube. A detector will measure the arrival time of the particles at the exit of the drift tube. H^--ion, which have almost identical electromagnetic properties to the antiprotons, will be used for comparison and as a calibration standard. 7 refs., 1 fig.

27057 (LBL–28547) **Measurements of the Z boson resonance parameters at SLC [SLAC Linear Collider].** Hearty, C. Lawrence Berkeley Lab., CA (USA). Jul 1989. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098.

(CONF-8907134–8: 17. SLAC summer institute: physics at the 100 GeV mass scale, Stanford, CA (USA), 10-21 Jul 1989). Order Number DE90009196. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper presents the measurement by the Mark II experiment at the SLAC Linear Collider of the parameters of the Z boson resonance. The results are updated from those presented at the SLAC Summer Institute to include all data presented in the most recent Mark II publication, consisting of 19 nb^{-1} of data at ten different center-of-mass energies between 89.2 and 93.0 GeV. The resonance parameters are extracted by measuring the Z production cross section at a series of center-of-mass energies (scan points) near the Z peak, then fitting these data with the theoretical cross section. The four major aspects of the analysis are the determination at each scan point of the center-of-mass energy (E), the integrated luminosity, the number of Z decays and the expected cross section as a function of the resonance parameters, such as mass and width. I will discuss each of these steps in turn, after a brief description of the Mark II detector, then conclude with the results of the analysis. 7 refs., 9 figs., 3 tabs.

27058 (LBL–28673) **Search for the top quark in electron-muon events with CDF.** Barbaro-Galtieri, A. The CDF Collaboration. Lawrence Berkeley Lab., CA (USA). Feb 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8909291–6: 8. topical workshop on proton-antiproton collider physics, Castiglione della Pescaia (Italy), 1-5 Sep 1989). Order Number DE90009047. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The CDF detector has collected data for an integrated luminosity of 4.4 pb^{-1} during the 1988–89 Tevatron Collider run. This sample has been used to search for the top quark. We report here the results of the analysis of the electron-muon topology. We find that a top mass in the 28 to 72 GeV is excluded at the 95% confidence level. The same limits apply to a possible fourth generation, charge −1/3, b′ quark decaying via the charged current. 21 refs., 14 figs.

27059 Experimental bounds on interactions mediated by ultralow-mass bosons. Heckel, B.R. (Physics Department, University of Washington, Seattle, Washington 98195 (USA)); Adelberger, E.G.; Stubbs, C.W.; Su, Y.; Swanson, H.E.; Smith, G.; Rogers, W.F. *Physical Review Letters (USA),* 63(25): 2705-2708 (18 Dec 1989).

We use a rotating torsion balance to search for feeble forces arising from exchange of ultralow-mass bosons. Our limits on the differential horizontal acceleration of Be/Al or Be/Cu test-body pairs in the field of the Earth, $\Delta a_{\perp}=(1.5\pm2.3)\times10^{-11}$ cm s^{-2} and $\Delta a_{\perp}=(0.9\pm1.7)\times10^{-11}$ cm s^{-2}, respectively, set improved bounds on interactions mediated by bosons with masses ranging between 10^{-17} and 10^{-6} eV.

6452 Particle Interactions and Properties - Theoretical

Refer also to citation(s) 27025, 27248, 27358

27060 (BNL–44368) **Prospects for top at the tevatron collider in the 1990's.** Abachi, S. (Fermi National Accelerator Lab., Batavia, IL (USA)); Butler, J.; Baden, D.; Barnett, B.; Matthews, J.A.; Buchholz, D.; Gordon, H.; Protopopescu, S.; Hedin, D.; Kim, Shinhong. Brookhaven National Lab., Upton, NY (USA). [1989]. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890872–10: Workshop on physics at Fermilab in the 1990's, Breckenridge, CO (USA), 15-24 Aug 1989). Order Number DE90009492. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We calculated the signal and background rates for top masses of 90, 120, 150, and 180 GeV for both the CDF and DØ detectors. This allowed us to determine the prospects for both discovery as well as detailed study of heavy top depending on the luminosity. We have focused on the leptons + jets and dilepton signatures. We also consider the question of tagging b-jets and how that should reduce background and help in making a mass determination. 8 refs., 5 figs., 5 tabs.

27061 (ENEA-RT-TIB–89-15) **The Cayley-Klein parameters and geometrical picture of the multilevel system evolution.** Dattoli, G.; Richetta, M.; Torre, A. ENEA, Frascati (Italy). Centro Ricerche Energia. Jul 1989. 29p. (RT/TIB–89-15). Order Number DE90764295. Available from NTIS (US Sales Only), PC A03/MF A01.

Submitted to Physical Review D.

In this paper we complete the study of the evolution of multilevel systems in terms of a geometrical picture based on the so-called Cayley-Klein parameters introduced to describe rotations in classical mechanics. It is shown that these parameters and their identification in terms of Euler angles are helpful and insightful tools to clarify the dynamical features of two and three-level atoms interacting with intense external radiation. It is finally shown that the evolution of e.g. the three level case depend on a rotations matrix fully equivalent to the Kobayashi-Maskawa matrix introduced in elementary particle theory to account for generalized Cabibbo mixing angles and CP-Violations in weak decay processes.

27062 (FNAL/C–90/48-T) ϵ'/ϵ **and heavy top.** Paschos, E.A. (Fermi National Accelerator Lab., Batavia, IL (USA)); Schneider, T.; Wu, Y.L. Fermi National Accelerator Lab., Batavia, IL (USA). Mar 1990. 29p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-900185–1: 1990 Aspen winter conference on elementary particle physics, Aspen, CO (USA), 14-20 Jan 1990). Order Number DE90009077. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The article reviews the new theoretical developments for the CP-parameter ϵ'/ϵ and its intimate connection with the mass of a heavy top quark. 22 refs., 8 figs., 1 tab.

27063 (IC–89/214) **Heavy meson spectroscopy.** Chakrabarty, S. International Centre for Theoretical Physics, Trieste (Italy). Aug 1989. 40p. Order Number DE90622564. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this article we give a review of certain aspects of the present understanding of spectroscopy of heavy mesons and constituent quark masses in the light of non-relativistic potential model approach motivated by quantum chromodynamics. We find that the one gluon exchange at short distance and colour-confining interaction at large distance which is pure scalar (or scalar-vector admixture with dominant scalar interaction) under the Lorentz transformation, can explain only partially the present data on 1P states of cc-bar and bb-bar states. The S-wave data, that are available at present, however can be understood with both scalar confinement or scalar-vector admixture with scalar-dominant interaction. (author). 44 refs, 13 tabs.

27064 (IC–89/260) **Multiple photon emission and b quark asymmetries.** Jadach, S. (Uniwersytet Jagiellonski, Cracow (Poland). Inst. Fizyki); Ward, B.F.L. International Centre for Theoretical Physics, Trieste (Italy). Aug 1989. 8p. Contract DE-AS05-76ER03956;Contract DE-AC03-76SF00515. (CONF-8906210–: Workshop on B-factories and related physics issues, Blois (France), 26 Jun - 1 jul 1989; UTHEP–89-0902). Order Number DE90622565. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We discuss the effects of multiple photon final states in high precision tests of the $SU_{2L} \times U_1$ model wherein one measures the b quark asymmetries at a very high luminosity Z^0 factory, such as the possible high luminosity upgrade of the CERN LEP collider. The specific asymmetries analyzed are the forward-backward asymmetry A_{FB}, the left-right polarized asymmetry A_{LR} and the polarized forward-backward asymmetry $A_{FB,pol.}$. The radiative effects are found to be significant for A_{FB} as expected, but they are not as large, on a percentage basis, as the corresponding result for muons. (author). 5 refs, 1 tab.

27065 (IC–89/261) **Theoretical uncertainties in semi-leptonic B-decay.** Ward, B.F.L. International Centre for Theoretical Physics, Trieste (Italy). Aug 1989. 6p. Contract DE-AS05-76ER03956. (CONF-8906210–: Workshop on B-factories and related physics issues, Blois (France), 26 Jun - 1 jul 1989; UTHEP–89-0901). Order Number DE90622538. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We consider here the issue of how well one can calculate the B meson semi-leptonic branching ratio $\Gamma(B \rightarrow l\nu\text{-bar}_l + X)/\Gamma(B \rightarrow \text{all})$, where $\Gamma(B \rightarrow X)$ is the decay width of B to the final state X. We consider both inclusive and exclusive indicators. Possible applications to B-factory type physics are discussed. (author). 10 refs.

27066 (IC–89/369) **A systematic study of strongly localized almost massless systems.** Bozic, B.; Mankoc-Borstnik, N. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 19p. Order Number DE90622595. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Properties of strongly localized almost massless clusters of constituents were systematically studied in the potential model of independent particles. The potential has a vector and a scalar part. For appropriate choices of potential, constituents are ultrarelativistic, strongly localized and almost massless ($(\tau)E < 10^{-6}$), with the anomalous magnetic moment proportional to $e(\tau)$ - properties characteristic of quarks and leptons in constituent models. It is shown that rather large choices of potentials with vector and scalar parts enable such properties. (author). 15 refs, 6 figs.

27067 (IC–89/404) **Looking for supersymmetry in rare B-meson decays.** Aliev, T.M. (International Centre for Theoretical Physics, Trieste (Italy)); Dobroliubov, M.I. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 12p. Order Number DE90622566. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We investigate manifestations of SUSY in rare B-meson decays $B_d \rightarrow K^0\phi$, $K^+\pi^-$ which proceed mainly via penguin diagrams. It is shown that there exists a range of masses of SUSY particles where SUSY contribution to the amplitudes of the processes exceeds the standard one. We obtain constraints on SUSY particles masses which may be competitive with the accelerator ones. (author). 11 refs, 4 figs.

27068 (LAPP-TH–243-89) **Expectations from strong electroweak sector at Tevatron and SantippS.** Chiappetta, P. (Grenoble-1 Univ., 74 - Annecy (FR). Lab. de Physique des Particules); Casalbuoni, R.; Dominici, D.; Feruglio, F.; Gatto, R. Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. 1989. 13p. Order Number DE90770332. Available from NTIS (US Sales Only), PC A03/MF A01.

We have calculated the expectations for the Tevatron and for SantippS from a model for electroweak symmetry breaking due to a strong interacting sector. We present some illustrative examples of transverse momentum distributions in inclusive production of leptons from W-decays. We compare with QCD background. We note in particular that, in case the anomalous UA1 events are real, visible deviations from the standard model would be predicted at the Tevatron.

27069 (LAPP-TH–251-89) **Top quark mass bounds in the hierarchical chiral symmetry-breaking framework.** Albright, C.H. Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. May 1989. 13p. Order Number DE90770259. Available from NTIS (US Sales Only), PC A03/MF A01.

By taking account of recent information on the B_d - antiB_d mixing parameter, x_d, and the product $B_B f^2_B$, as well as uncertainties in the lighter quark masses, we are able to set search limits on the top quark mass of 84 ± 8 GeV for the Fritzsch mass matrices with two Higgs doublets or 78 ± 12 GeV for a modified set of Fritzsch mass matrices with minimal Higgs structure. We comment on the discovery complications involved when the top mass is very close to the W mass. If no top quark is eventually found with mass less than 100 - 110 GeV, the whole 3-family hierarchical chiral symmetry-breaking framework proposed by Fritzsch is ruled out.

27070 (NBI-HE–89-40(prepr.)) **Thinking about the weak boson as a light bound state.** Schlereth, H. Niels Bohr Inst., Copenhagen (Denmark). Sep 1989. 19p. Order Number DE90622539. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We suggest to look upon a composite weak boson as a light bound state, that is $m_W << \Lambda_W$ (Λ_W scale of compositeness). It is pointed out that in this case the low energy effective theory drives towards renormalizability and that at LEP 200 this case can be distinguished from the weak boson being a gauge particle. We argue that Weyl fermions are promising candidates as subconstituents avoiding problems arising with other more conventional choices, such as the appearance of light scalar bound states. We present a lattice regularization with gauged SU(2) hypercolor and discuss some special phenomenological features arising from a selfdual channel characteristic for the Weyl fermion scenario. (orig.).

27071 (NBI-HE–89-51) **Hadronization of quark flavor dynamics.** Reinhardt, H. (Niels Bohr Inst., Copenhagen (Denmark)). Niels Bohr Inst., Copenhagen (Denmark). Dec 1989. 19p. Order Number DE90622567. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

By path integral bosonization low-energy quark flavor dynamics is converted into quantum hadrodynamics. (orig.).

27072 (OUP–90-01) **Note on s anti s-production in anti p-nucleus reactions at 607 MeV/c incident momentum.** Breivik, F.O. (Oslo Univ. (Norway). Fysisk Inst.); Haatuft, A.; Halsteinslid, A. LEAR Collaboration. Oslo Univ. (Norway). Fysisk Inst. Jan 1990. 8p. Project CERN-PS-179. Order Number DE90622568. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The measured cross sections for K^o s and Λ^o (Σ^o) production in anti pA reactions at 607 MeV/c incident momentum, and the number of quark recombinations, give the cross section σ(s anti s) for strange particle production for target nuclei with A= 2, 4 and 20 nucleons, respectively. The result favours the relation σ(s anti s) $\propto A^{1/3}$. Scattering of an antiquark off a virtual s anti s-pair, or gluon Bremsstrahlung emitted by scattering of an incident antiquark passing through nuclear matter, are possible processes consistent with this relation. Models inconsistent with the relation may be wrong. 4 refs.; 2 tabs.

27073 (PCCF-T–8810) **Contribution to the theoretical study of the meson symmetric pair production, at high P_T, from the proton-proton interactions in the Brodsky-Lepage formalism: comparison with the double fragmentation model.** Djagouri, K. Clermont-Ferrand-2 Univ., 63 - Aubiere (France). Lab. de Physique Corpusculaire. 1988. 167p. (In French). Order Number DE90770194. Available from NTIS (US Sales Only), PC A08/MF A01.

The semi-exclusive production of a charged mesons symmetric pair, in hadronic interactions, is presented. The high transverse impulsion mesons are ejected at 90^0, in their center-of-mass system with regard to the axis of interaction. The main physical principles of the high transverse impulsions in hadronic collisions are reviewed. Three meson pair production processes are considered: (a) the 2 jets production followed by a double fragmentation; (b) production of one meson by jet fragmentation and, the other, by direct production; (c) the direct production of two mesons by means of the Brodsky-Lepage mechanism. An accurate analysis of this mechanism is given. An analytical calculation of the three processes, leading to the 2 pseudoscalar or vectorial mesons, is performed. The results of the proton-proton and proton-antiproton interactions, for different energies, are presented. The Baier et al. standard parameterization is applied to the distribution functions and to the quarks and gluons fragmentation. It is shown that, concerning the production, the direct Brodsky-Lepage-type process, by double fragmentation, prevails. Morever, the process increases with increasing interaction energy. In hadronic interactions, this process can probably be detected. A detailed analytical calculation is given.

27074 (RAL–89-113) **Two-photon couplings of $I = 0$ scalars and tensors from analysis of new $\gamma\gamma \rightarrow \pi\pi$ data.** Morgan, D. (Rutherford Appleton Lab., Chilton (UK)); Pennington, M.R. Rutherford Appleton Lab., Chilton (UK). Nov 1989. 6p. (CONF-8909221–: HADRON '89: 3rd international conference on hadron spectroscopy, Ajaccio (France), 23-27 Sep 1989). Order Number DE90622555. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

New data on $\gamma\gamma \rightarrow \pi^+\pi^-$ and $\pi^0\pi^0$ admit an amplitude analysis whereby two-photon couplings of the $I = 0$ scalars and of the $f_2(1270)$ can be extracted in a much more model independent way than hitherto. Alternative trial forms respecting known properties at low energies and of final state interactions are fitted to the data.

The ensuing resonance couplings span a much wider range than is commonly supposed. The best fits correspond to solutions with a relatively large S-wave coupling (≈ 8keV) through the f_2-region. All fits have an S* coupling of about 1/2 keV. (author).

27075 (RAL–89-126) **Exotic atoms and the kaon-nucleon interaction.** Batty, C.J. Rutherford Appleton Lab., Chilton (UK). Dec 1989. 13p. (CONF-8910383–: Workshop on intense hadron facilities and antiproton physics, Turin (Italy), 23-26 Oct 1989). Order Number DE90622569. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

To be published in 'Atti delle Conferenze - Conference Proceedings' by the Italian Physical Society (SIF).

Recent progress in the study of p-bar-p and p-bar-nucleus atoms is briefly reviewed before moving on to a discussion of the kaon-nucleon interaction at low energies. The need for new definitive X-ray measurements for K^-p atoms is emphasised. Finally some comments are made about K-bar-nucleus and Σ^-, Ξ^- and Ω^- atoms. (author).

6453 Particle Invariance Principles and Symmetries

Refer also to citation(s) 27053, 27062, 27079

27076 (LA-UR–90-1002) **An upper bound on right-chiral weak interactions.** Stephenson, G.J. (Los Alamos National Lab., NM (USA)); Goldman, T.; Maltman, K. Los Alamos National Lab., NM (USA). [1990]. 5p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900183–2: Recontres De Moriond '90: new and exotic phenomena, Les Arcs (France), 20-27 Jan 1990). Order Number DE90008917. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Weak vertex corrections to the quark-gluon vertex functions produce differing form-factor corrections for quarks of differing chiralities. These differences grow with increasing four-momentum transfer in the gluon leg. Consequently, inclusive polarized proton–proton scattering to a final state jet should show a large parity-violating asymmetry at high energies. The absence of large signals at sufficiently high energies can be interpreted as being due to balancing vertex corrections from a right-handed weak vector boson of limited mass, and limits on the strength of such signals can, in principle, give upper bounds on that mass. 2 refs.

27077 **Scalar fields and the cosmological constant.** Abbott, L. F. (Physics Dept., Brandeis Univ., Waltham, MA (US)). pp. 348 of Relativity supersymmetry and cosmology. Bressan, O.; Castagnino, M.; Hamity, V. World Scientific Pub. Co., Teaneck, NJ (USA) (1985). (CONF-8501110–: 5. SILARG on relativity supersymmetry and cosmology, Bariloche (Argentina), 4-11 Jan 1985).

The author explores the possibility of introducing a compensating scalar field which dynamically adjusts its vacuum energy in order to produce, in a natural way, an acceptably small cosmological constant. The necessary dynamical mechanisms are developed in a detailed discussion of symmetry breaking and phase transitions in de Sitter and anti-de Sitter spacetimes. A working, although unrealistic, model is presented.

27078 **SU(15) grand unification.** Frampton, P.H. (Institute of Field Physics, Department of Physics and Astronomy, University of North Carolina, Chapel Hill, North Carolina 27599-3255 (USA)); Lee, B. *Physical Review Letters (USA),* 64(6): 619-621 (5 Feb 1990).

A grand unified model based on SU(15) is described. Baryon-numbe-violating processes such as proton decay are absent in both the gauge and Higgs sectors. A number of new gauge bosons are predicted at Superconducting Super Collider energy, including doubly charged gauge bosons coupling only to leptons.

6454 Field Theory

Refer also to citation(s) 27066, 27077

27079 (CONF-890001–1) **Some global problems in gauge theories (Variations on a theme of Aharonov and Bohm).** Wilczek, F. Institute for Advanced Study, Princeton, NJ (USA). School of Natural Sciences. Dec 1989. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER02220. (IASSNS-HEP–90/19). From Conference on thirty year of the Aharonov-Bohm effect; Columbia, SC (USA); Order Number DE90009034. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Several situations are discussed, in which the sort of global considerations made famous by Aharonov and Bohm in their discussion of the interaction of charged particles with magnetic flux tubes have important physical implications. It is argued that discrete gauge symmetries in the continuum make sense, and manifest themselves most clearly in Aharonov-Bohm type scattering of charged particles off string singularities. The existence of such discrete symmetries has important implications for the quantum mechanics of topologically non-trivial space-times in general and black holes in particular. It is argued that in the non-abelian case essentially new features arise, most notably that the symmetry group of the homogeneous ground state generally ceases to be globally defined in the presence of a string. When continuous rather than discrete symmetries are involved, a variety of fascinating and as yet poorly understood dynamical effects occur. Perhaps the most striking is a new form of string superconductivity, that exists for purely topological reasons, and is not well modeled by regarding the string as a superconducting wire. 8 refs., 2 figs.

27080 (CONF-8907186–1) **Rings.** Davis, R.L. Institute for Advanced Study, Princeton, NJ (USA). [1989]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER02220. (IASSNS-HEP–89/48). From Cambridge cosmic strings workshop; Cambridge, MA (USA); Jul 1989. Order Number DE90009035. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The essence of vortex physics is that at certain low-energy scales elementary excitations of a point particle theory can behave like strings rather than particles. Vortices are the resulting string-like solutions; their thickness sets the distance scale beyond which physics is string-like rather than particle-like. String degrees of freedom are massless in the sense that excitations on a string can have an arbitrarily low frequency. Non-string degrees of freedom correspond to massive particles and are absent from the low energy spectrum. This article considers only field theories with vortices at low energies. The possible existence of a class of solitons in these vortex theories will be discussed. They are vortex rings: they are localized and finite in energy, and able to carry the quantum numbers of point particles. Rings are thus particle-like solutions of a vortex theory, which is itself a limit of a point particle field theory.

27081 (IC–89/201) **Dynamics of massless higher spins in the second order in curvatures.** Vasiliev, M.A. International Centre for Theoretical Physics, Trieste (Italy). Aug 1989. 15p. Order Number DE90622229. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The consistent equations of motion of interacting fields of all spins s=0,1/2,1...∞ are constructed explicitly to the second order of the expansion in powers of the higher spin strengths. (author). 14 refs.

27082 (IC–89/259) **Exceptional quantum groups.** Koh, I.G.; Ma Zhongqi. International Centre for Theoretical Physics, Trieste (Italy). Sep 1989. 15p. Order Number DE90622230. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The braids R-circumflex, the underlying structure of the Boltzmann weight of the solvable lattice model, are obtained for the fundamental representation of the exceptional quantum group E_6. The symmetry properties of quantum Clebsch-Gordan coefficients and the braids R-circumflex under the Weyl reflection are noted. The fusion matrices of the E_6 WSW models and the link polynomials are constructed. The symmetries of the braids R-circumflex predict the symmetry of the Boltzmann weights of the vertex model based on the E_6. The E_7 and F_4 quantum groups are briefly commented. (author). 11 refs, 2 figs, 1 tab.

27083 (IC–89/323) **Rigorous QED-proof of the Langevin equations for high-Q cavity fields.** Knoell, L. (Jena Univ. (German Democratic Republic). Sektion Physik); Vogel, W.; Welsch, D.G. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 11p. Order Number DE90622231. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Starting from the inhomogeneous quantum mechanical Maxwell equations we give a rigorous quantum-field theoretical derivation of the Langevin equations for a high-Q cavity field and specify the conditions of validity without borrowing from the standard relaxational treatment. In particular, we show that the use of Langevin equations means loss of information about field changes during times of the order of the time of flight of a light signal through the cavity, which may be crucial in pico- and femtosecond spectroscopy. (author). 8 refs.

27084 (IC–89/324) **Quantum gravity in two dimensions and the SL(2,R) current algebra.** Helayel-Neto, J.A. (DCP-CBPF, Rio de Janeiro, RJ (Brazil)); Mokhtari, S.; Smith, A.W. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 12p. Order Number DE90622232. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Gravity coupled to a scalar field in two dimensions is studied and it is shown that in the light cone gauge there exists a new symmetry associated with the scalar field that leads naturally to the SL(2,R)-Kac-Moody current algebra. This algebra is derived from the traceless part of the energy momentum tensor whose conservation is shown to give the well-known constraint necessary to obtain the chiral SL(2,R) algebra. (author). 8 refs.

27085 (IC–89/357) **Topological Higgs mechanism with ordinary Higgs mechanism.** Oda Ichiro (Chiba Univ. (Japan). Dept. of Physics); Yahikozawa Shigeaki. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 10p. Order Number DE90622233. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Topological Higgs mechanism in higher dimensions is analyzed when ordinary Higgs potential exists. It is shown that if one-form B-field becomes massive by the ordinary Higgs mechanism, another D-2 form C-field also becomes massive through topological term in addition to the topological mass generation by the topological Higgs mechanism. Moreover we investigate this mechanism in three dimensional theories, that is to say, Chern-Simons theory and more general theory. (author). 10 refs.

27086 (IC–89/363) **QED in non-simply connected regions.** Barut, A.O.; Duru, I.H. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 9p. Order Number DE90622234. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

It is shown that QED radiative processes of an atom, like Lamb shift and spontaneous emission, are modified in the presence of a one-dimensional "mirror" at a distance R by an amount proportional to $1/R^2$, compared to a 2-dimensional mirror where it is proportional to $1/R^4$. (author). 15 refs.

27087 (IC–89/408) **Tetrahedra and polynomial equations in topological field theory.** Chair, N.; Zhu Chuanjie. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 42p. Order Number DE90622235. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Some tetrahedra in $SU_k(2)$-Chern-Simons-Witten theory are computed. The results can be used to compute an arbitrary tetrahedron inductively by fusing with the fundamental representation. The results obtained are in agreement with those of quantum groups. By associating a (finite) topological field theory (FTFT) to every rational conformal field theory (RCFT), we show that the pentagon and hexagon equations in RCFT follow directly from some skein relations in FTFT. By generalizing the operation of surgery on links in FTFT we derive also an explicit expression for the modular transformation matrix S(k) of the one point conformal blocks on a torus in RCFT and the equations satisfied by S(k), in agreement with those required in RCFT. The implication of our results on the general programme of classifying RCFT is also discussed. (author). 24 refs, 21 figs.

27088 (IC–89/416) **Morse theory applied to N=1 and 2 superconformal theories.** Marzban, C. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 9p. Order Number DE90622236. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Various spaces are singled-out as candidates for the space of all 2-d N=1 and 2 supersymmetric quantum field theories, respectively. This is done by treating the c-function as a Morse-function on these spaces. (author). 10 refs.

27089 (NBI-HE–89-43) **Field transformations, collective coordinates and BRST invariance.** Alfaro, J. (Universidad Catolica de Chile, Santiago (Chile). Facultad de Fisica); Damgaard, P.H. Niels Bohr Inst., Copenhagen (Denmark). Dec 1989. 35p. Contract FONDECYT 0394/88. Order Number DE90622237. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A very large class of general field transformations can be viewed as a field theory generalization of the method of collective coordinates. The introduction of new variables induces a gauge invariance in the transformed theory, and the freedom left in gauge fixing this new invariance can be used to find equivalent formulations of the same theory. First the Batalin-Fradkin-Vilkovisky formalism is applied to the Hamiltonian formulation of physical systems that can be described in terms of collective coordinates. We then show how this type of collective coordinate scheme can be generalized to field transformations, and discuss the War Identities of the associated BRST invariance. For Yang-Mills theory a connection to topological field theory and the background field method is explained in detail. In general the resulting BRST invariance we find hidden in any quantum field theory can be viewed as a consequence of our freedom in choosing a basis of coordinates $\phi(\chi)$ in the action $S[\phi]$. (orig.).

27090 (NBI-HE–89-47) **Duality ensures modular covariance.** Li Miao (Niels Bohr Inst., Copenhagen (Denmark)); Yu Ming. Niels Bohr Inst., Copenhagen (Denmark). Nov 1989. 15p. Order Number DE90622238. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We show that the modular transformations for one point functions on the torus, S(n), satisfy the polynomial equations derived by Moore and Seiberg, provided the duality property of the model is ensured. The formula for S(n) is derived by us previously and should be valid for any conformal field theory. As a consequence, the full consistency conditions for modular invariance at higher genus are completely guaranteed by duality of the theory on the sphere. (orig.).

27091 (NBI-HE–89-48) **1/N-expansion of the non-linear σ-model: The first three orders.** Flyvbjerg, H.; Varsted, S. Niels Bohr Inst., Copenhagen (Denmark). Nov 1989. 4p. (CONF-8909249–:). Order Number DE90622239. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The two-point function of the O(N)-symmetric non-linear σ-model is expanded in 1/N, keeping terms of three leading orders. The mass gap and the magnetic susceptibility obtained from the two-point function are evaluated on square lattices for N=3 and N=4. Using recent high precision Monte Carlo data as bench marks, the systematic error on the truncated 1/N-expansion is smaller than the terms neglected to any of the three orders at hand. Actually, the non-linear σ-model with $N \geq 3$ is little more than a Gaussian model in a one-component auxiliary field, as far as the mass gap and magnetic susceptibility are concerned. (orig.).

27092 (NBI-HE–89-54) **Perturbation theory of higher-spin conserved currents off-criticality.** Cappelli, A. (Niels Bohr Inst., Copenhagen (Denmark)); Latorre, J.I. Niels Bohr Inst., Copenhagen (Denmark). Nov 1989. 36p. Order Number DE90622240. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Minimal conformal theories perturbed by the least relevant field are an interesting and computable framework for studying Zamolodchikov's currents of higher spin, which suggest the integrability of the off-critical theory. After clarifying the perturbative technique, a generalization of the c-theorem for currents of any spin is given and applied in this context. Mixing of descendent fields in the infrared limit of the renormalization-group flow is shown. The Ward identity for conservation of the spin-four current is given, and shown to encode a dynamical symmetry of the theory away from criticallity. (orig.).

27093 (NBI-HE–89-56) **Random surfaces: A non-perturbative regularization of strings?.** Ambjoern, J. Niels Bohr

Inst., Copenhagen (Denmark). Dec 1989. 18p. (CONF-8908189–: Workshop on probabilistic methods in quantum field theory and quantum gravity, Cargese (France), 21-27 Aug 1989). Order Number DE90622241. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

I review the basic properties of the theory of randum surfaces. While it is by now well known that the theory of (discretized) random surfaces correctly describes the (perturbative) aspects of non-critical strings in d<1 and 2D-gravity coupled to matter with central charge c<1, not much is known about the non-critical strings for d>1. In these lectures I intend to show that the theory of dynamical triangulated random surfaces provides us with a lot of information about the dynamics of both the bosonic string and the superstring even for d>1. I also briefly review recent attempts to define a string field theory (sum over all genus) in this approach. (orig.).

27094 (OUP–89-27) **A comparison of two S-matrices in QED.** Kolsrud, M. Oslo Univ. (Norway). Fysisk Inst. Dec 1989. 7p. Order Number DE90622242. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

For the quantum electrodynamics case of a quantized Dirac field, interacting only with an unquantized Maxwell field, the S-matrices of G. Scharf and the author are shown to be identical, apart from a phase factor.

27095 Critical behavior in (2+1)-dimensional QCD. Appelquist, T. (Department of Physics, Yale University, New Haven, Connecticut, 06520 (USA)); Nash, D. *Physical Review Letters (USA)*, 64(7): 721-724 (12 Feb 1990).

QCD in 2+1 dimensions with N species of fermions, analyzed in the $1/N$ expansion, is shown to exhibit a chiral and confinement phase transition as N approaches a critical value N_c. For $N>N_c$, the theory is chirally symmetric and deconfined. For $N<N_c$, chiral symmetry is broken and confinement sets in at momentum scales less than the fermion mass. The reliability of the $1/N$ expansion when $N \geq N_c$ is discussed, and the behavior of this theory is contrasted with QCD in 3+1 dimensions.

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6510 Nuclear Physics

Refer also to citation(s) 27381

27096 (DOE/ER/40410–2) **Nuclear structure investigations on spherical nuclei: Progress report.** Heisenberg, J.; Calarco, J.; Dawson, J.; Hersman, F.W. New Hampshire Univ., Durham, NH (USA). Dept. of Physics. Sep 1989. 76p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER40410. Order Number DE90009357. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

This report discusses the following topics: electron scattering studies on spherical nuclei; electron scattering from collective states in deformed nuclei; proton and pion scattering studies; $^{12}C(e,e'p)$ and $^{16}O(e,e'p)$; $^{12}C(e,e'\alpha)$ and $^{16}O(e,e'\alpha)$; studies at high q at Bates; measurements with $\vec{e}$ at Bates; $^{12}C(\gamma,p)$; future directions in giant resonance studies; proton knockout from ^{16}O; quasielastic studies at Bates; triple coincidence studies of nuclear correlations; contributions to (e,e'2p) at KIKHEF; contributions to instrumentation at CEBAF; instrumentation development at UNH; the Bates large acceptance spectrometer toroid; shell model and core polarization calculations; and the relativistic nuclear model.

27097 (ORNL/TM–11414) **Comparisons of experimental beta-ray spectra important to decay heat predictions with ENSDF [Evaluated Nuclear Structure Data File] evaluations.** Dickens, J.K. Oak Ridge National Lab., TN (USA). Mar 1990. 48p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007966. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Graphical comparisons of recently obtained experimental beta-ray spectra with predicted beta-ray spectra based on the Evaluated Nuclear Structure Data File are exhibited for 77 fission products having masses 79–99 and 130–146 and lifetimes between 0.17 and 23650 sec. The comparisons range from very poor to excellent. For beta decay of 47 nuclides, estimates are made of ground-state transition intensities. For 14 cases the value in ENSDF gives results in very good agreement with the experimental data. 12 refs., 77 figs., 1 tab.

27098 Quadrupole moments determined from muonic x-rays. Hoehn, M.V. (Los Alamos National Lab., NM (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609463–: Symposium on nuclear spectroscopic quantities: their determination and use, Anaheim, CA (USA), 7-12 Sep 1986).

Quadrupole moments of certain nuclei can be accurately determined by observation of the quadrupole hyperfine-splitting energies of muonic x rays. Analysis of muonic data yields a very precise radial nuclear moments that can be combined with nuclear-model assumptions or with other experimental measurements of nuclear transition charge densities to determine point-nucleus quadrupole parameters. In the case of medium or high-Z odd-A nuclei, the model dependence of the extracted quadrupole moments is negligibly small, even in the absence of transition-density data from other experiments. The concepts involved in extracting moments from muonic atom data and a summary of recent muonic-atom measurements of quadrupole and hexadecapole moments will be presented.

27099 Transfer of B and C fragments from 0-18 projectiles to heavy actinide targets. Gregorich, K.E. (Lawrence Berkeley Lab., CA (USA)); Henderson, R.; Nurmia, M.; Lee, D.; Chasteler, R.; Hall, H.; Gannett, C.; Bennett, D.; Hoffman, D.C. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract AC03-76SF00098. (CONF-8609464–: American Chemical Society Division of Nuclear Chemistry and Technology, Anaheim, CA (USA), 7-12 Sep 1986).

One of the main goals of LEAP is to study the nuclear and chemical properties of elements 104 and 105 produced in irradiations of a large Es-254 target by the transfer of B and C fragments from light heavy ion projectiles. Some preliminary investigations have been carried out to help predict the cross sections for these B and C transfers. Targets of Cm-248, Bk-249, and Cf-249 were bombarded with 0-18 beams at the LBL 88-Inch Cyclotron and the short-lived alpha and spontaneous fission activities from the decay of No, Lr, and Rf were measured using the MG-RAGS rotating wheel system. Results are presented and the prospects for further work, including the use of large Es-254 target are discussed.

27100 Excitation functions for production of actinides from reactions of ^{16}O ions on ^{249}Cf. Chasteler, R.M. (Lawrence Berkeley Lab., CA (USA)); Henderson, R.A.; Lee, D.; Gregorich, K.E.; Nurmia, M.J.; Welch, R.B.; Hoffman, D.C. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract AC03-76SF00098. (CONF-8609464–: American Chemical Society Division of Nuclear Chemistry and Technology, Anaheim, CA (USA), 7-12 Sep 1986).

Excitation functions have been measured for the production of isotopes of berkelium through fermium in bombardments of Cf-249 with 90- to 150-MeV O-16 ions. The measured cross sections and widths of the mass distributions for the actinides produced in these reactions are very similar for transfer of the same number of nucleons. A comparison of the mass distribution curves from this experiment with reactions of Cf-249 with O-18 ions shows unexpected shifts in these curves as compared to those that have been measured with similar light-heavy ion pairs on Cm-248. However, the shifts appear similar to those recently measured in reactions of light-heavy ion pairs on Es-254.

27101 Production cross-sections for heavy actinides in the bombardment of ^{249}BK with ^{18}O. Hall, H.L. (Lawrence Berkeley Lab., CA (USA)); Gannett, C.M.; Bennett, D.; Lee, D.; Gregorich, K.E.; Henderson, R.A.; Hoffman, D.C. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE

Contract AC03-76SF00098. (CONF-8609464--: American Chemical Society Division of Nuclear Chemistry and Technology, Anaheim, CA (USA), 7-12 Sep 1986).

Production cross-sections of actinides in the region Cf to Md have been measured in the reaction of ^{18}O with ^{249}Bk. These results lead to preliminary mass yield curves which can be compared with earlier results from the reactions of ^{248}Cm and ^{249}Cf with ^{18}O. In general, it is noted that the shape and width of the mass yield curves are similar to the earlier results for ^{248}Cm and ^{249}Cf for transfers of the same mass and Z. ^{249}Bk is also of particular interest since it is an odd Z target and thus should be somewhat analogous to the ^{254}Es target used in LEAP.

27102 Radiochemical studies of lawrencium. Henderson, R.A.; Silva, R.J.; Gregorich, K.E.; Nurmia, M.; Hall, H.L.; Gannett, C.M.; Bennett, D.; Chasteler, R.M.; Chu, Y.Y.; Shanyu Cai. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract AC03-76SF00098. (CONF-8609464--: American Chemical Society Division of Nuclear Chemistry and Technology, Anaheim, CA (USA), 7-12 Sep 1986).

Using the isotope Lr-260 produced in reactions of Ne-22 + Es-254 and O-18 + Bk249, the authors have been able to perform chemical experiments on lawrencium to learn more about its chemical properties. These experiments involved TTA extractions, α-HIB elution from a cation column, and reverse-phase chromatography using HDEHP. The TTA extractions were used to measure the production cross sections of Lr-260 and to make sure that Ac was not the source of the 8.03 MeV alpha activity. The results from the α-HIB elutions give information about the ionic radius of Lr(III), which was found to elute very close to Er. They are using a variety of reducing agents in an attempt to prepare Lr(I).

27103 Odd-mass nuclei: The unpaired nucleon as a probe of collective core structure. Semmes, P.B. (Holifield Heavy Ion Research Facility, Oak Ridge, TN (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract AS05-76ER04936. (CONF-8609463--: Symposium on nuclear spectroscopic quantities: their determination and use, Anaheim, CA (USA), 7-12 Sep 1986).

The collective properties of even-even nuclei are often revealed in the structure of their odd-mass neighbors, in particular, through level energies and E2/M1 properties. Thus, experimental studies of odd-mass nuclei have been used to deduce features of the even-even core (such as the nuclear shape) that can be difficult to determine otherwise. Particle-core coupling models provide the necessary link between the structure of the even-even core and the properties of the odd-mass neighbor. The general form of these models will be discussed, along with their strengths and limitations for elucidating core structure. Finally, recent applications of particle-core coupling will be presented, with particular emphasis on the Pt-Hg region.

27104 Reactions of nucleogenic lead and bismuth activated by the 216Po (-alpha)212Pb and 212Pb (-beta)21Bi nuclear transformations. Parks, N.J. (Univ. of California, Davis (USA)); Mishra, A.C.; Bharadwaj, P.K. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609464--: American Chemical Society Division of Nuclear Chemistry and Technology, Anaheim, CA (USA), 7-12 Sep 1986).

Using a generator system which provided a convenient source of ^{216}Po by the bubbling of ^{220}Rn through chemical systems of interest, they have examined the reactions of its daughter, ^{212}Pb, activated by alpha decay and ^{212}Bi activated by beta decay with aromatic and aliphatic compounds. In the early experiments that have been performed, ^{212}Pb compounds were formed in benzene solvent that cannot be extracted by neutral pH aqueous extracts. These ^{212}Pb compounds which are soluble in organic media maintained the radionuclide in intimate contact with the organic reactants of interest and allowed examination of the nucleogenic reactions of ^{212}Bi. Current efforts to determine whether ^{212}Bi organometallic compounds result from intra- or inter-molecular interactions will be described. This work was supported by US DOE, Office of Health and Environmental Research.

27105 Design and operation of a generator system for studies of reactions activated by nuclear transformation and synthesis of alpha-emitting radiopharmaceutical compounds. Mishra, A.C. (Univ. of California, Davis (USA)); Chelton, K.C.; Parks, N.J. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609464--: American Chemical Society Division of Nuclear Chemistry and Technology, Anaheim, CA (USA), 7-12 Sep 1986).

The authors will describe a facile method of obtaining Pb-212 ($t_{1/2}$ = 10.6 hr) and Bi-212 ($t_{1/2}$ = 61 min.) for chemical effects of nuclear transformation studies and a source for alpha-emitting coordination compounds and organometallic compounds. The design they have chosen for the present studies permits the aerosol-free removal of Rn-220 ($t_{1/2}$ = 56 sec) emanating from aqueous solution of Ra-224 ($t_{1/2}$ = 3.7 d) and its parent Th-228 ($t_{1/2}$ = 1.9 y). They will present the operating parameters and shielding requirements for production of radionuclides from a 25 mCi source. This will include results of operation as a static and stirred system and temperature dependence. This work was supported by US DOE, Office of Health and Environmental Research.

27106 Ex-plant consequence analysis: Models, typical results, uncertainties, chemistry. Sprung, J.L. (Sandia National Labs., Albuquerque, NM (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938--: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

Ex-plant consequence analysis is the customary final step in the probabilistic analysis of the risks of severe nuclear reactor accidents. The elements of an ex-plant consequence analysis are described, typical results presented, and controlling phenomena, uncertainties, and the importance of chemical form identified.

27107 Roundtable discussion of nuclear spectroscopic quantities - Their determination and use. Wood, J.L. (Georgia Institute of Technology, Atlanta (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract AS05-80ER10599. (CONF-8609463--: Symposium on nuclear spectroscopic quantities: their determination and use, Anaheim, CA (USA), 7-12 Sep 1986).

The tools now available for nuclear spectroscopy permit studies of extraordinary breadth and detail. Capabilities generally lie considerably beyond the existing data base for any nucleus. When extended mass regions are considered, one finds that there are essentially no regions studied with the full spectroscopic potential at hand. The main reason for this is that such undertakings place heavy demands on manpower. They have reached a point in the study of low-energy nuclear structure where it is necessary to be highly selective in the problems chose for study. To ensure that the best problems are selected, strong interaction between theory and experiment is needed. Experimentalists need to be aware of the kind of structure problems that can be posed. Theoreticians need to be aware of the potential for generating new spectroscopic information with the available state-of-the-art techniques. With this in mind, the status of the topics covered in this symposium will be discussed with an eye on where the experiments and theoretical developments need to be directed in near future studies.

27108 The chemistry of nuclear reactor accidents: Problems and progress. Parker, G.W. (Oak Ridge National Lab., TN (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938--: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

Any evaluation of the chemical effects to be expected in severe reactor accidents involving primarily the high-temperature interaction of core and coolant must account for the extremes of both oxidation and reduction reactions since they can lead to widely diverse phenomena. No study of core-melt chemistry can be definitive without recognizing the importance of the powerful effect of the

environment imposed by the characteristic thermal-hydraulics of each class of hypothetical accidents as well as that demonstrated by TMI-2. In the work done thus far in this area, significant new effects of materials interactions, time-dependent temperature gradients, and size-related geometric factors have been observed. Especially sensitive to these effects are the control materials - boron and silver - and the fission - tellurium, strontium, barium, and molybdenum. The releases measured in these experiments were less than those predicted by the radiological source-term reassessment, which is often quoted as being less conservative and more realistic than the source-term estimates of 1974.

27109 **The role of chemistry in nuclear accidents.** Johnson, C.E. (Argonne National Lab., IL (USA)); Johnson, I. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

An accurate description of the chemical state of fission products is required for quick response in assessing the impact of nuclide release during a nuclear accident. The chemical state of the fission products is certain to change in response to their local environment. More specifically, fission products released from fuel will change their composition on contact with high-temperature steam, and these changes will determine their behavior with regard to either transport, deposition, aerosol formation, or reaction with structural components. The local oxygen potential is a key parameter in establishing the chemical state of the fission products and their release and transport mechanisms. Knowledge of the relationship of this parameter and thermal hydraulics is needed for prediction of fission product behavior in degraded core accidents. The behavior of key fission products in various stages of an accident, based on experimental results and appropriate calculations founded on fundamental thermodynamic information, will be discussed.

27110 **Chemical characteristics of material released during source term experiments project (STEP) in-pile tests: Part I.** Schlenger, B. (Argonne National Lab., IL (USA)); Dunn, P.F.; Herceg, J.E.; Simms, R.; Horton, E.L.; Baker, L. Jr. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

A series of 4 experiments aimed at characterizing the radiological source term associated with postulated severe light water reactor accidents has been conducted at Argonne's Transient Reactor Test Facility (TREAT). The STEP tests drove 4 fuel elements to the point of severe cladding disruption in a steam environment by fission heating and oxidation of the Zircaloy cladding. The released fission products and volatile cladding constituents entrained in the steam/hydrogen flow were captured by the test vehicle sampling systems and analyzed by SEM/EDX. Elemental and morphological data will be presented. The principal constituents of the deposits were fission product cesium, molybdenum and rubidium and tin from the cladding. Iodine was seen colocated with cesium. The composition information, in conjunction with counted particle distributions, are used to characterize the portion of the released material that is transported in aerosol form.

27111 **Chemical characteristics of material released during source term experiments project (STEP) in-pile tests: Part II.** Fink, J.K. (Argonne National Lab., IL (USA)); Roche, M.F.; Seils, C.A.; Steidl, D.V.; Johnson, C.E.; Ritzman, R.L. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

This paper focuses on the chemical aspects of materials transport and fission-product release during in-pile STEP experiments at TREAT. The STEP experiments and aerosol-release measurements are given in Part I. STEP collection coupons, tabs, and wires were examined for fission products and reactor materials by electron microprobe microanalysis and secondary-ion mass spectroscopy. Out-of-pile experiments were performed to facilitate the interpretation of the chemical reactions and transport mechanisms. In general, iodine was either co-located with cesium as flat crystals and rods or co-located with cesium and silver as long, hairlike rods. The small amount of tellurium in the deposits was consistent with laboratory experiments indicating that tellurium is mainly deposited at temperatures higher than those of the STEP samples. Tin from the zircaloy cladding was a dominant species in deposits from all the tests. Differences in the deposits from the high-pressure tests and low-pressure tests will be presented.

27112 **The unusual bonding of actinide systems.** Brewer, L. (Lawrence Berkeley Lab., CA (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609360–: Symposium on solid-state actinide chemistry and physics, Anaheim, CA (USA), 7-12 Sep 1986).

The actinide elements have unusual bonding capabilities because of the availability of 5f, 6d, 7p, and 7s orbitals. Spectroscopic data along with predictive models are complete enough to assign promotion energies for the various electronic configurations and the bonding contributions of the various types of electrons. The availability of a number of electronic configurations of comparable stability makes it possible for actinide metals to form complex structures in which atoms in different lattice positions have different electronic configurations and different sizes. Bonding models provide predictions of thermodynamic properties that can be used to calculate phase diagrams of many systems with reasonable accuracy. The major challenge is provided by mixtures of actinide metals with platinum group metals because of very strong generalized Lewis Acid-Base Interactions that are difficult to characterize with sufficient accuracy. The behavior of a wide range of actinide systems will be reviewed.

27113 **The behavior of hybridizing light actinide systems.** Cooper, B.R. (West Virginia Univ., Morgantown (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract FG05-84ER45134. (CONF-8609360–: Symposium on solid-state actinide chemistry and physics, Anaheim, CA (USA), 7-12 Sep 1986).

Correctly treating the electronic structure and magnetic behavior of metallic systems of moderately delocalized light actinides requires understanding the way in which the highly correlated behavior of the f electrons within the actinide ion is linked to the band behavior via the hybridization process. This understanding can be gained by viewing the hybridization process as a resonant scattering of band electrons of non-f atomic parentage interacting with the correlated f-electrons in the moderately delocalized ions. Their theoretical work, developed on the basis of such a model, involves both model Hamiltonian studies in which the parameters needed are evaluated phenomenologically and calculations where they find these parameters from first principles using crystal potentials from self-consistent band structure calculations. They will relate their theoretical work to a variety of experiments, emphasizing the use of PuSb as a model system for understanding the important mechanisms.

27114 **Importance of environment on high temperature reactor accident chemistry.** Elrick, R.M. (Sandia National Labs., Albuquerque, NM (USA)); Sallach, R.A. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

Adequate transport models and codes are essential for predicting the progress of light water reactor accidents. Prediction of the transport of chemical species by these codes requires an adequate data base. The High Temperature Fission Product Chemistry Program at Sandia helps provide some of those data that identify and characterize chemical processes in the reactor coolant system that could dominate during severe accidents. Experiments, conducted under accident-type conditions which include steam and hydrogen, provide data for estimating the extent of reaction and the rates at

which fission products react with surfaces. These surfaces are those of various reactor materials - structure, control rod, cladding and fuel - whether the materials are in bulk structure or aerosol particles. Developments in the Program highlight the important role the reactor environment plays in the chemistry and transport of fission product species of cesium, iodine and tellurium in the primary system.

27115 **Downstream behavior of fission products.** Johnson, I. (Argonne National Lab., IL (USA)); Johnson, C.E.; Farahat, M.; Settle, J.L.; Ritzman, R. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

The downstream behavior of fission products (Cs, I, and Te) has been studied by injection into a stream of super-heated steam and analyzing the deposits formed on the wall of a reaction duct on which a temperature gradient (1,000-200°C) had been imposed. Deposits were formed by vapor and aerosol deposition. Studies of mixtures of CsI and CsOH indicated that the formation of a complex, CsI · CsOH, in the gas phase influenced the vapor deposition. Studies of mixtures of CsOH, CsI, Te, and TeO_2 indicated the existence of gas phase reactions between Te, TeO_2, and CsOH which effected the deposition. The revaporization of fission product deposits, as would occur due to radioactive decay heating, has been studied by the rapid heating of a section of the reaction duct, on which a deposit had been formed, in a stream of steam.

27116 **Influence of chemical form on cesium revaporization from the reactor coolant system.** Powers, D.A. (Sandia National Labs., Albuquerque, NM (USA)); Bieniarz, P. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

Radionuclides released during a severe accident as the reactor fuel degrades may deposit in the reactor coolant system. Convective heating and heating caused by radioactive decay may raise the temperatures of such deposits to the point significant revaporization occurs. Such revaporization seriously limits the mitigation of release caused by deposition in the coolant system when the chemical form of cesium is taken to be CsOH. Cesium may react, however, to form other, less volatile species. In this paper a detailed, non-ideal solution model of the cesium borate system is presented. It is shown that revaporization of cesium deposited as various borates can be slowed or even negligible relative to the revaporization of CsOH. Alteration of the chemical form of cesium can alter significantly the likelihood cesium will contribute to radionuclide release from a nuclear plant during a severe accident.

27117 **Optical and magnetic properties of tetravalent actinide ions and compounds.** Edelstein, N. (Lawrence Berkeley Lab., CA (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract AC03-76SF00098. (CONF-8609360–: Symposium on solid-state actinide chemistry and physics, Anaheim, CA (USA), 7-12 Sep 1986).

A survey will be given of the optical and magnetic data available for tetravalent actinide ions in a variety of crystals and as pure compounds. Where possible, conclusions will be drawn from the values of the free ion parameters in crystals when compared with the values for the free ions in the gaseous phase. Problems with the theoretical model will be discussed.

27118 **The magnetic properties of compounds containing the $5f^6$ ions Am_3, and Cm^{4+}.** Soderholm, L. (Argonne National Lab., IL (USA)); Morss, L.R.; Edelstein, N.M.; Shalimoff, G. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract W-31109-ENG-38. (CONF-8609360–: Symposium on solid-state actinide chemistry and physics, Anaheim, CA (USA), 7-12 Sep 1986).

The magnetic behavior of compounds containing Am^{3+} or Cm^{4+} is reviewed, and new results on tetravalent curium are discussed. These ions are isoelectronic, have a J=0 ground state, and therefore should exhibit van Vleck temperature-independent paramagnetism (TIP) at temperatures less than 300 K. Previous studies on materials containing these ions reported a small temperature dependence to the observed paramagnetism, and in the cases where a temperature-independent contribution was reported, the magnitude of the susceptibility is much larger than expected from calculation. The results of their measurements on Am^{3+} containing compounds agree well with theory, exhibiting only TIP. They have addressed the Cm^{4+} case by preparing a solid solution of curium in the perovskite $BaCeO_3$, the curium replacing tetravalent cerium. The authors discuss the stability and magnetic properties of Cm^{4+} in this host.

27119 **Structural and spectroscopic characterization of uranium-sulfur compounds.** Perry, D.L. (Lawrence Berkeley Lab., CA (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609360–: Symposium on solid-state actinide chemistry and physics, Anaheim, CA (USA), 7-12 Sep 1986).

Of the three uranium-chalcogen systems that have been investigated, the most divergent types (and greatest number) of compounds reported in the research literature concern the uranium-sulfur bond. These compounds include simple binary compounds, ternary compounds involving metals in addition to uranium, uranium-sulfur and uranium-sulfur-oxygen chelates, and uranium-sulfur coordination compounds. The uranium-sulfur linkage not only affords compounds that demonstrate the interesting synthetic chemistry that is possible, but it also exists in solid state materials that exhibit a wide range of magnetochemical and electrical properties. The present talk centers around structural and spectroscopic studies of solid state uranium-sulfur compounds. Different subclasses of these compounds are discussed, and spectroscopic techniques are described that have been used to characterize them. Electronic spectroscopic studies of both bulk and surface properties of several of these compounds are discussed, along with results of surface reactions associated with them.

27120 **Insights on severe accident chemistry from TMI-2.** Hobbins, R.R. (EG and G Idaho, Idaho Falls (USA)); Langer, S.; Owen, D.E.; Akers, D.W.; Cronenberg, A.W. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

Chemical analyses are being carried out on materials removed from the damaged reactor at TMI-2. Characteristics of TMI-2 fuel, control, fission product and structural materials based on these analyses are presented. Emphasis is placed on chemistry within the pressure vessel although descriptions of, and postulated mechanisms for, materials transported from the vessel to the reactor building are also discussed. Indications of the oxygen potential in the reactor pressure vessel during the high temperature phase of the accident are of particular significance for the analysis of damage progression and fission product behavior during severe accidents. The results of thermodynamic and kinetic calculations for chemical species present during the high temperature portion of the accident (during core uncovery) and which are consistent with measured end states in the reactor pressure vessel are presented. Insights on chemistry of significance for severe accident analysis which follow from the evaluation of the TMI-2 accident are discussed.

27121 **Fission product behavior in the TMI-2 core: Preliminary evaluation of transport and chemistry.** Akers, D.W. (EG and G Idaho Inc., Idaho Falls (USA)); Hobbins, R.R.; Langer, S.; Adams, J.P. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

Within the past several years, samples of debris have been obtained from the plenum region, the upper debris bed and the lower reactor head of the damaged TMI-2 reactor. Results of these examinations are compared with fission product behavior under severe fuel damage conditions similar to TMI-2 as determined from integral and separate effects tests. Chemical mechanisms that could produce the observed fission product behavior are evaluated in light of the current understanding from experiment and theory. The principal radionuclides discussed are the isotopes of cesium and iodine. Evaluations of the behavior of less volatile fission products (i.e. ruthenium, antimony and strontium) are also presented. Measured ^{137}Cs and ^{129}I retentions in the debris are higher than expected whereas ^{125}Sb and ^{106}Ru retentions are lower than expected based on estimated core temperatures.

27122 **The release and transport of fission product cesium in the TMI-2 (Three Mile Island-Unit 2) accident.** Lorenz, R.A. (Oak Ridge National Lab., TN (USA)); Collins, J.L. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

Approximately 55% of the fission product cesium was released from the overheated UO_2 fuel in the TMI-2 (Three Mile Island-Unit 2) accident and was transported mainly to a water pool that formed in the basement of the containment structure. Steam that boiled away from a pool in the bottom of the reactor vessel transported the released fission products throughout the Reactor Coolant System (RCS). Some fission products passed directly through a leaking valve, but most deposited on dry surfaces before being dissolved or resuspended when the RCS was refilled with water. Laboratory test with non-TMI deposits of fission product cesium gave leach rates that were in good agreement with the TMI scenario. It was necessary to develop a TMI fission product transport model since the measurements at TMI occurred after most of the deposition, resolution, and liquid purging had taken place. The transport model confirms results being obtained with complex models used in studies of severe light water reactor accidents.

27123 **Analysis of fission product transport behavior during severe fuel damage experiments.** Osetek, D.J. (Idaho National Engineering Lab., Idaho Falls (USA)); Sherry, R.R.; Reed, P.R. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

This paper summarizes the analytical interpretation of the physicochemical behavior of fission products released, transported and deposited during Severe Fuel Damage (SFD) experiments conducted in the Power Burst Reactor Facility (PBF) and compares the calculation with measured behavior. The SFD experiments are designed to simulate the degraded thermal hydraulic environment of the nuclear reactor core and reactor vessel upper plenum at high temperature (> 2,400 K) accident conditions. The test measurements and analyses indicate the following behavior for the important iodine and cesium radionuclide species: cesium is being transported predominantly as CsOH and iodine as CsI. The test results indicate that little, if any, iodine was transported in a more volatile chemical form such as molecular iodine or HI. The observed transport behavior of other radionuclide species (except noble gases) indicate that they nucleated to form aerosols in the region between the core and the upper plenum. In one test extensive aerosol formation from the nonradioactive Ag-In-Cd control rods was observed.

27124 **Fission product behavior during the in-pile severe fuel damage test SFD (severe fuel damage).** Vinjamuri, K. (Idaho National Lab., Idaho Falls (USA)); Osetek, D.J.; Meikrantz, D.H.; Baker, J.D. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

The Severe Fuel Damage (SFD) Test SFD 1-3 was conducted in the Power Burst Facility at the Idaho National Engineering Laboratory. The SFD 1-3 test assembly used previously irradiated (37 MWd/tU) PWR fuel rods. Operational conditions of the test included boildown and dryout of the top 80% of the bundle, followed by controlled heatup simulating an LWR heatup by decay heat following loss of coolant. The peak transient temperatures reached were 2,300 and 2,600 K. The entire effluent from the fuel bundle consisting of super-heated steam, condensable vapors, aerosols, and noncondensable gases was routed from the in-pile tube through a heated and insulated line to a sampling and monitoring system. The samples were analyzed using a variety of analytical techniques. Results are presented in terms of release fractions, release rates and distribution of fission products. The probable chemical forms of the predominant fission product species are presented; and the release transport, and deposition of fission products are discussed.

27125 **Fission product deposition behavior.** Baker, J.D. (Idaho National Engineering Lab., Idaho Falls (USA)); Meikrantz, D.H.; Simpson, O.D. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

The chemical behavior of fission products generated and released during Severe Fuel Damage transients is an important aspect of reactor safety research. However, the direct identification, study, and analysis of SFD samples for individual chemical characteristics is difficult. The samples are highly radioactive which requires special handling and modification of classical analytical techniques. Also, the species of interest are often trace quantities as compared to the environmental materials with which they are mixed. As a result, the deposition and leaching behavior of certain radioisotopes has been studied to provide insight toward likely chemical species formed and their respective transport behavior. This talk will discuss deposition behavior of Cs^{137}, Sr^{90}, Te^{127m}, Ba^{140} and I^{131} during the most recent two Power Burst Facility tests at the Idaho National Engineering Laboratory. Deposition data for each of these radionuclides on both horizontal and vertical surfaces will be presented.

27126 **Angle-resolved and resonant photoemission in actinide materials.** Arko, A.J. (Argonne National Lab., IL (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract W-31109-ENG-38. (CONF-8609360–: Symposium on solid-state actinide chemistry and physics, Anaheim, CA (USA), 7-12 Sep 1986).

Though the spatial extent of the 5f orbitals in the light actinides is limited, it is sufficient for hybridization with ligand electrons, and results in a rich variety of physical properties, such as, the recently-discovered heavy electron systems. Angle-resolved photoemission measurements utilizing synchrotron radiation, together with resonance at the 5d core absorption edge, probe the electronic structure of these 5f systems, the former determining the energy dispersion of the 5f band states, the latter measuring the partial 5f density. Hybridization with the ligand p- or d-electrons is the main mechanism for stabilizing a 5f band, especially for heavy Fermions where photoemission shows a very narrow, nearly pure-5f subband at E_F in an otherwise broad 5f spectrum. Even in well localized systems such as UO_2 there is 5f admixture in the ligand p-bands. In general there is good agreement between measured and calculated bands lending credence to the validity of such calculations for 5f systems.

27127 **Chemical physics of heavy fermion uranium compounds.** Fisk, Z. (Los Alamos National Lab., NM (USA)); Smith, J.L.; Ott, H.R. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609360–: Symposium on solid-state actinide chemistry and physics, Anaheim, CA (USA), 7-12 Sep 1986).

A number of intermetallic compounds of uranium have been found recently to possess conduction electron effective masses two to three orders of magnitude larger than found in usual metals. The

authors discuss the occurrence of such compounds and review aspects of their unusual low temperature behavior.

27128 Actinides and their heavy electrons. Smith, J.L. (Los Alamos National Lab., NM (USA)); Fisk, Z.; Thompson, J.D.; Willis, J.O. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609360–: Symposium on solid-state actinide chemistry and physics, Anaheim, CA (USA), 7-12 Sep 1986).

It appears that some progress has been made on the question of localized vs. itinerant f-electrons in metallic actinide compounds. This can be derived from the properties of the so-called heavy fermion materials, where the electrons have effective masses hundreds of times larger than free electrons. Their properties will be reviewed. Their importance and implications for understanding actinides will be discussed.

27129 Preparation and solid state properties of americium and curium bismuthides. Gibson, J.K. (Oak Ridge National Lab., TN (USA)); Haire, R.G.; Nave, S.E.; Moore, J.R. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract AC05-84OR21400;AS05-79ER10348. (CONF-8609360–: Symposium on solid-state actinide chemistry and physics, Anaheim, CA (USA), 7-12 Sep 1986).

The solid state chemistry and magnetic properties of the transplutonium bismuthides are of interest as bismuth is the pnictogen with the largest radius and thus provides the greatest actinide-actinide separation of all the pnictides. Monobismuthides of americium-243 and curium-248 have been prepared and possess the NaCl-type structure. The lattice parameter obtained for AmBi is in agreement with the literature value (a_0 = 6.34 A); in contrast, the lattice parameter found for CmBi is significantly larger than the anomalously small value previously reported for it (a_0 = 6.24 A). Both AmBi and CmBi have been subjected to magnetic investigations. The properties of the bismuthides will be compared to those available for other transplutonium pnictides.

27130 Risk-significance of chemical issues affecting the source term. Williams, D.C. (Sandia National Labs., Albuquerque, NM (USA)); Griesmeyer, J.M. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

Under NRC sponsorship, Sandia National Laboratories is implementing the Severe Accident Risk Reduction Program (SARRP), in which state-of-the-art risk assessment techniques are being applied to the evaluation of severe accident risks in selected nuclear power plants representative of US plant types. SARRP includes major efforts to characterize the uncertainties in the risks and identify the principal contributors to these uncertainties. This paper will present and compare quantitative results obtained for uncertainties involving the source term in the Surry PWR and Peach Bottom BWR plants. Techniques used include statistical analyses based upon Latin Hypercube sampling. Results obtained to date show that important uncertainties include those involving iodine chemistry, high-temperature fission product chemistry, phenomena involved in the high-pressure ejection of corium into containment, and radionuclide release during corium-concrete interactions. The importance of the various issues depends strongly upon the specific accident sequence and the plant type.

27131 Impact of chemical phenomena in direct containment heating. Williams, D.C. (Sandia National Labs., Albuquerque, NM (USA)); Bergeron, K.D.; Carroll, D.E.; Tills, J.L. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

One of the most important unresolved issues governing risk in many nuclear power plants involves the phenomenon called direct containment heating (DCH), in which it is postulated that molten corium ejected from the reactor vessel under high pressure is dispersed into the containment atmosphere, thereby causing sufficient heating and pressurization to threaten containment integrity. Calculations using the CONTAIN code for severe accident analysis suggest that DCH can pose a severe threat to PWR large dry containments (the most common US type) if and only if there is substantial chemical energy release resulting form oxidation of metal in the dispersed corium. Unresolved questions governing the magnitude of the chemical energy release include steam-oxygen competition for the available metal, rate-limiting processes in the oxidation reactions, and catalysis of the hydrogen-oxygen reaction by dispersed corium. In addition, radionuclide release from the dispersed fuel potentially can enhance the source term, but the chemical processes governing this release have only begun to be explored. CONTAIN calculations and other results will be presented, illustrating the potential impact of these issues upon the containment failure probability and the associated source term.

27132 Experimental studies of transplutonium metals and compounds under pressure. Peterson, J.R. (Univ. of Tennessee, Knoxville (USA)); Haire, R.G.; Young, J.P.; Benedict, U. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract AS05-76ER04447;AC05-84OR21400. (CONF-8609360–: Symposium on solid-state actinide chemistry and physics, Anaheim, CA (USA), 7-12 Sep 1986).

X-ray diffraction (XRD) studies of actinide materials under pressure allow measurement of the pressure-volume behavior (equation of state) and provide information about pressure induced phase transition. The diamond anvil cells used for these measurements can also be used for studying the optical absorption spectra of non-opaque actinide compounds as a function of pressure. Absorption spectra are determined by the local order about a metal ion, in contrast to the long-range order probed by XRD techniques. Thus, spectral information may provide an analysis of higher resolution and/or sensitivity than does XRD information. The results of XRD analysis of Am, Cm, Bk, and Cf metals and Bk-Cf alloys under pressure will be summarized and discussed. Spectra of selected transplutonium halides under pressure will also be presented and interpreted in terms of pressure effects.

27133 Equilibrium and structural properties of phases in the Pu+O+H system. Haschke, J.M. (Rockwell International, Golden, CO (USA)); Hodges, A.E. III; Lucas, R.L. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609360–: Symposium on solid-state actinide chemistry and physics, Anaheim, CA (USA), 7-12 Sep 1986).

Results of recent studies suggest that the Pu+H and Pu+O systems are more complex than indicated by previous studies and that ternary oxide hydrides are formed by the reaction of water with the metal or the hydride at 250°C. Equilibrium pressure data for the PuH_{2+x} ($0 < x > 1$) solid solution show regions with different dependencies of the partial molar free energy on composition. Diffraction data indicate that anion defect clusters exist in the hydride and that phase relationships of Pu+H are determined by structural influences of the metal and hydrogen sublattices. Kinetic data for hydrolysis of Pu and PuH_{2+x} show that two oxide hydride and six oxide phases form in sequence. Formation of these phases is consistent with the occurrence of anion substitution and cation altervalence processes in fluorite-related structures and suggest that the Pu+O and Pr+O systems are similar.

27134 Studies of plutonium and curium tri-iodides under pressure. Haire, R.G. (Oak Ridge National Lab., TN (USA)); Young, J.P.; Peterson, J.R.; Benedict, U. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract AC05-84OR21400;AS05-76ER04447. (CONF-8609360–: Symposium on solid-state actinide chemistry and physics, Anaheim, CA (USA), 7-12 Sep 1986).

Anhydrous tri-iodides of plutonium and curium have been investigated as a function of pressure in a diamond anvil cell. Absorption spectrophotometry and x-ray diffraction techniques were used to monitor the effects of pressure. Previous work on americium tri-iodide has shown it to be dimorphic. When pressure is applied on

americium tri-iodide its rhombohedral crystal form converts to its orthorhombic form. The other actinide tri-iodides were known previously to exist in only one of two crystal forms (rhombohedral or orthorhombic) depending on the actinide. The work presented here on plutonium and curium tri-iodides determined that applying pressure on these materials also brings about structural transformations. These changes can be interpreted as reflecting a preferred packing efficiency in the orthorhombic crystal form.

27135 **Interpretation of neptunium spectra in some crystalline and non-crystalline solids.** Carnall, W.T. (Argonne National Lab., IL (USA)); Goodman, G.L.; Veal, B.W.; Lam, D.J. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract W-31109-ENG-38. (CONF-8609360–: Symposium on solid-state actinide chemistry and physics, Anaheim, CA (USA), 7-12 Sep 1986).

Recent progress in the interpretation of the spectra of compounds containing U(IV) and U(V) has provided a useful basis for the attempt to develop a systematic understanding of the spectra of heavier actinides in the same valence states. The authors will discuss new insights into the analysis of the spectra of compounds such as $NpCl_4$, $Np(OH)_2SO_4$, and $CsNpF_6$ in this context. In non-crystalline solids such as silicate glasses designed for waste isolation, the problem of interpretation of spectroscopic data is more fundamental. It is first of all necessary to identify the valence state(s) of the actinide ions present. Thus they will also discuss application of their spectroscopic measurements, including spectra of Np_2O_5 and NpF_4, to the identification of the valence states of neptunium in silicate glasses prepared under oxidizing as well as under reducing conditions.

27136 **The chemistry of fission product iodine under nuclear reactor accident conditions.** Malinauskas, A.P. (Oak Ridge National Lab., TN (USA)); Bell, J.T. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract AC05-84OR21400. (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

Iodine radionuclides have been generally acknowledged to be the dominant contributors to early radiological dose arising from severe core damage accidents. The dose estimates involved, however, have been based upon a simplistic view of iodine chemistry. More realistic assessments of radioiodine behavior in nuclear reactor accidents require that consideration be given to the varying chemical environments which are involved in the course of the transport of the iodine fission products from their points of origin, as impurity atoms in the uranium dioxide lattice, to their eventual possible escape into the biosphere. Descriptions of these chemical environments and of the chemical interactions involved are presented.

27137 **Iodine behavior in containment under LWR accident conditions.** Wisbey, S.J. (Oak Ridge National Lab., TN (USA)); Beahm, E.C.; Shockley, W.E.; Wang, Y.M. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

The description of containment iodine behavior in reactor accident sequences requires an understanding of iodine volatility effects, deposition and revaporization/resuspension (from surfaces and aerosols), chemical changes between species, and mass transport. The experimental work in this program has largely centered on the interactions of iodine in or with water pools. The formation of volatile iodine, as I_2 or organic iodides, is primarily dependent on radiation and solution pH. Lower pH results in increased formation of volatile iodine species; thus, for example, a pH of 3.05 resulted in a conversion of I^- to I_2 that was more than two orders of magnitude greater than tests run at pH 6.1 or 6.8. The formation of organic iodides involving water pools has been linked to the presence of iodine as I_2, the solution/gas contact, and to the type of organic material.

27138 **Analysis of iodine chemical form noted from severe fuel damage experiments.** Cronenberg, A.W. (ESA-Inc., Idaho Falls, ID (USA)); Osetek, D.J. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

Data from the TMI-2 accident has shown that only small amounts of iodine (I) escaped the plant. The postulated reason for such limited release is the formation of CsI (a salt) within fuel, which remains stable in a reducing high-temperature steam-H_2 environment. Upon cooldown CsI would dissolve in water condensate to form an ionic solution. However, recent data from fuel destruction experiments indicate different iodine release behavior that is tied to fuel burnup and oxidation conditions, as well as fission product concentration levels in the steam/H_2 effluent. Analysis of the data indicate that at low-burnup conditions, atomic I release from fuel is favored. Likewise, at low fission product concentration conditions HI is the favored chemical form in the steam/H_2 environment, not CsI. Results of thermochemical equilibria and chemical kinetics analysis support the data trends noted from the PBF-SFD tests. An a priori assumption of CsI for risk analysis of all accident sequences may therefore be inappropriate.

27139 **Contain code calculations of the effects on the source term of cesium iodide to elemental iodine conversion due to severe hydrogen burns.** Valdez, G.D. (Technadyne, Albuquerque, NM (USA)); Williams, D.C. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

In experiments conducted at Sandia National Laboratories large amounts of elemental iodine were produced when CsI-Al_2O_3 aerosol was exposed to hydrogen/air combustion. The Al_2O_3 was a surrogate for the chemically inert aerosols which would accompany the CsI release in a severe reactor accident. To evaluate some of the implications of the iodide conversion (observed to occur with up to 75% efficiency) for the source term, computational simulations of the accident sequences were conducted with the CONTAIN code. The following conclusions can be drawn from this preliminary source term assessment: (1) If the containment sprays are inoperative during the accident or failed by the hydrogen burn, the late-time source term due to debris concrete interactions is almost tripled when the iodide is converted to I_2. (2) With the sprays active, the amount released without conversion of the CsI aerosol is 63% higher than for the case when conversion occurs. (3) For the case where CsI is converted to I_2 continued operation of the sprays reduces the release by a factor of 40, relative to the case in which the sprays fail at the time of the hydrogen burn. When there is no conversion, the reduction factor for continued spray operation is about a factor of 9, relative to the failed-spray case.

27140 **Capture of iodine in pressurized water reactor ice condensers.** Owczarski, P.C. (Pacific Northwest Lab., Richland, WA (USA)); Winegardner, W.K. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

When analyzing postulated severe accidents, there is concern that gas phase elemental iodine (I_2) and organic iodide (represented by methyl iodide, CH_3I) might exist in addition to solid (particulate) phase cesium iodide (CsI) in reactor containment gases. Pacific Northwest Laboratory has developed the computer code ICEDF that estimates the ice condenser decontamination factors (DFs) for each of the three chemical species. Particles are scrubbed effectively by steam condensation and, if the particles are large, by gravity settling. I_2 is scrubbed very effectively if the ice melt water is alkaline (from sodium tetraborate in the ice). CH_3I is partially scrubbed when high liquid flow rates are encountered. During a typical accident sequence when ice is present, DFs range

from 1 to 2 for CH_3I, from 50 to 600 for particulate CsI, and 3E+9 to 5E+10 for I_2. After all ice is melted, these DFs are about 1, 2 and 2, respectively.

27141 Radionuclide release and aerosol generation during core debris interactions with concrete. Powers, D.A. (Sandia National Labs., Albuquerque, NM (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

During severe accidents at nuclear power plants, it is possible for the reactor fuel to melt and penetrate the reactor vessel. This can lead to vigorous interaction of core materials (UO_2, ZrO_2, Zr, and stainless steel) with structural concrete. Sparging of the molten core debris by gases (H_2O and CO_2) liberated from the concrete can lead to rapid release of radionuclides from the core debris. A theoretical description of this release process has been developed and is called the VANESA model. The treatments in the VANESA model of the thermodynamics of radionuclide vaporization and the kinetic barriers to vaporization will be described. Predictions obtained from the model will be compared to the results of tests of core debris/concrete interactions.

27142 Hydrogen generation during fuel-coolant interactions. Berman, M. (Sandia National Labs., Albuquerque, NM (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

During a severe nuclear plant accident, molten fuel can contact water in the core region, the lower plenum, or in the cavity below the reactor vessel. The interactions that take place can vary from benign boiling to explosive fragmentation. If the fuel contains a metallic component, rapid oxidation of the metal can occur during the fuel-coolant interaction (FCI). Experiments have been conducted with about 20 kg of two kinds of thermite-generated molten fuel simulants: corium and iron-aluminum oxide. Both saturated and subcooled water were employed. The FCIs ranged from nonexplosive to highly explosive. During these tests, hydrogen was sampled in the test chamber. They found that up to 30% of the metal was reacted during the FCI. The extent of reaction appeared to depend more on the water subcooling than on the degree of fragmentation as measured by post-test sieving.

27143 Fission product release from core-concrete melts. Tetenbaum, M. (Argonne National Lab., IL (USA)); Fink, J.; Johnson, C.E.; Chasanov, M.; Gunther, W.H.; Spencer, B.W.; Ritzman, R.L.; Seghal, R. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

Fractional release values for lanthanum, barium, and strontium gaseous fission products species from a core-concrete melt have been obtained at 2,155 and 2,385 K based on vaporization measurements with a He-H_2O carrier gas. The initial core-concrete configuration consisted of a layer of limestone chips, a layer of urania fuel granules containing La_2O_3, BaO, and SrO in solid solution, and a metal layer consisting of a mixture of stainless steel and zircaloy between the fuel and concrete. The following trends in fission product release fraction values were found: Ba > Sr > La. Release fraction values based on measured release of fuel, cladding, structural, and concrete species are also presented. Large scale tests were carried out in which direct electrical heating was used to sustain an interaction between fully oxidized molten-core materials (corium) and a basemat of limestone concrete. UO_2 was not detected in the aerosol generated, but ZrO_2 was present as was amorphous silica.

27144 Rates of chemical reaction and atmospheric heating during core debris expulsion from a pressurized vessel. Powers, D.A. (Sandia National Labs., Albuquerque, NM (USA)); Tarbell, W.W.; Brockman, J.E.; Pilch, M. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

Core debris may be expelled from a pressurized reactor vessel during a severe nuclear reactor accident. Experimental studies of core debris expulsion from pressurized vessels have established that the expelled material can be lofted into the atmosphere of the reactor containment as particulate 0.4 to 2 mm in diameter. These particles will vigorously react with steam and oxygen in the containment atmosphere. Data on such reactions during tests with 80 kg of expelled melt will be reported. A model of the reaction rates based on gas phase mass transport will be described and shown to account for atmospheric heating and aerosol generation observed in the tests.

27145 Panel discussion: Which chemical processes and phenomena are potentially important with respect to describing nuclear plant accidents and their source terms. Kress, T.S. (Oak Ridge National Lab., TN (USA)); Clough, P.N.; Powers, D.A.; Torgerson, D.F.; Denning, R.S.; Ritzman, R.L. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-860938–: Symposium on chemical phenomena associated with radioactivity releases during severe nuclear plant accidents, Anaheim, CA (USA), 8-12 Sep 1986).

In general, the chemical forms of species govern their volatility, their mobility, and their reactivity. Therefore, chemical processes can exert major influences during virtually every phase of an accident sequence progression. The treatment of chemical processes is more advanced in some source term areas than in others. Thus, it is not altogether apparent where an improved treatment of the chemistry is needed or where it would result in significant impact on the source term calculation. Therefore, the charge to each member of this panel is to address the following: (1) what is the general status of the treatment of chemical processes in the determination of source terms? (2) What are the two or three most important phenomenological areas in which the greatest impact on the calculated accident progression and source terms would result from an improved understanding and treatment of the associated chemical processes?

27146 DOE plans for site characterization. Stein, R. (Dept. of Energy, Washington, DC (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

As mandated by the Nuclear Waste Policy Act, the DOE is currently planning activities for site characterization to evaluate three candidate sites for the permanent disposal of high-level nuclear waste. DOE plans for site characterization will be described in a separate Site Characterization Plan (SCP) for each candidate site. Each SCP will contain a synopsis of the conditions known about the site to date and the plans for obtaining additional information. These plans will describe field and laboratory investigations to be conducted in an effort to establish the geologic, hydrologic, geochemical, geomechanical, and climatologic conditions of the candidate site. These site characterization investigations will provide the data needed to demonstrate compliance with regulatory requirements. In addition, these data will be used to support repository design as well as provide confirmatory data in the regulatory process. Once established, the SCP will be the vehicle to guide the Departments activities over the next 5 to 7 years.

27147 Geochemical investigations during site characterization of high-level waste repositories. Alexander, D.H. (Office of Geologic Repositories, Washington, DC (USA)); Hanlon, C.L.; Mihm, K.A. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Geochemical processes such as precipitation, dissolution, sorption, and matrix diffusion affect the release of radionuclides from a high-level waste repository (HLWR). Geochemical investigations during site characterization for a HLWR will focus on quantifying the effects of these geochemical processes on the retardation and transport of key radionuclides over a site-specific range of conditions. An understanding of these processes will form the basis for developing models aimed at predicting radionuclide migration over thousands of years and demonstrating regulatory compliance with reasonable assurance. Predictive radionuclide migration models must consider the effects of rock and fluid heterogeneities in a dynamic system. Geochemical investigations and models developed during HLWR site characterization will contribute to the overall performance assessment of the HLWR system.

27148 High-level radioactive waste disposal: Key geochemical issues and information needs for site characterization. Brooks, D.J. (Nuclear Regulatory Commission, Washington, DC (USA)); Bembia, P.J.; Bradbury, J.W.; Jackson, K.C.; Kelly, W.R.; Kovach, L.A.; Mo, T.; Tesoriero, J.A. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Geochemistry plays a key role in determining the potential of a high-level radioactive waste disposal site for long-term radionuclide containment and isolation. The Nuclear Regulatory Commission (NRC) has developed a set of issues and information needs important for characterizing geochemistry at the potential sites being investigated by the Department of Energy Basalt Waste Isolation Project, Nevada Nuclear Waste Storage Investigations project, and Salt Repository Project. The NRC site issues and information needs consider (1) the geochemical environment of the repository, (2) changes to the initial geochemical environment caused by construction and waste emplacement, and (3) interactions that affect the transport of waste radionuclides to the accessible environment. The development of these issues and information needs supports the ongoing effort of the NRC to identify and address areas of geochemical data uncertainty during prelicensing interactions.

27149 The role of natural isotopes in evaluating geologic repository performance assessment models. Birchard, G.F. (Nuclear Regulatory Commission, Washington, DC (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Natural isotopes may be used as a clock for determining the rates of natural processes which are important to geologic disposal of high level waste. Such processes include ground water movement, solute transport and irreversible absorption. Isotopic data may be used as a check on model predictions which use field hydrology and laboratory geochemistry to predict behavior of radioactive waste in the geologic environment. NRC high level waste geochemical research has developed an approach using natural isotopes in identifying and isolating individual processes that affect radionuclide transport rates. A uranium ore body has been sufficiently characterized for use as a test case for transport model validation. Natural isotope dating and tracing methods using C-14, Cl-36, Tc-99, I-29 and uranium series disequilibria provide the data needed for validation of portions of a performance assessment model.

27150 Site characterization at Yucca Mountain, Nevada, by the Nevada Nuclear Waste Storage Investigations (NNWSI) project. Blanchard, M.B. (Dept. of Energy, Las Vegas, NV (USA)); Clanton, U.S. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

The Projects approach to site characterization is to acquire sufficient information using an Issues Hierachy concept to enable compliance to be demonstrated with applicable federal and state regulations (e.g. NRC, EPA, NEPA, and DOE). The NNWSI Issues Hierachy is subdivided into 47 issues (i.e. 19 characterization, 12 design and 16 performance) which must be resolved. The Information Needs required to resolve these issues has been tentatively identified (i.e., 89 characterization, 66 design, and 85 performance). Section 8.2 of the NNWSI Project Site Characterization Plan (SCP) will explain the rationale of the Issues Hierachy and the associated Information Needs, while Section 8.3 will provide a detailed description of each investigation, and associated testing, to satisfy the Information Needs. The papers presented in this session provide: (a) geologic and hydrologic framework, (b) identify the geochemical processes, (c) describe geochemical and transport modelling being developed, and (d) preliminary performance assessment of the radionuclide-releases considered likely 10,000 years after repository closure.

27151 An overview of the BWIP geochemistry program. Dahlem, D.H. (Dept. of Energy, Richland, WA (USA)); Furman, M.J. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

The Basalt Waste Isolation Project (BWIP) is investigating the feasibility of a geologic repository for nuclear waste in the Columbia River Basalts. A survey is presented of geochemical objectives, strategies, and tasks that are designed to determine if a nuclear-waste repository in basalt can effectively isolate radionuclides from the accessible environment. A two-fold strategy is employed that includes experimental and field investigations of near-field and far-field geochemical phenomena. The experimental and field studies are complementary. They are intended to define the geochemical environment prior to waste emplacement, waste-induced perturbations to the geochemical environment, retardation of radionuclide transport in groundwater, definition of the conceptual groundwater flow path in the Pasco Basin, and relate relatively short-term experimental results to the repository life-time scale. Each of these activities are directed at particular issues identified as important to the geochemical behavior of radionuclides in a geologic repository. A conclusive demonstration that the pre-waste emplacement geochemical environment and the waste-induced perturbations will either enhance or not adversely affect the repository isolation capability is a necessary part of the license process.

27152 An overview of the salt program. Sherwin, J. (Dept. of Energy, Columbus, OH (USA)); Heston, S. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Deaf Smith County in the Palo Duro Basin is under consideration as a potential salt repository site by the US Department of Energy. Various geochemical investigations in terms of mineralogy, chemistry, hydrology, and isotopic studies are undertaken to characterize this site. These investigations are presented.

27153 Overview of the crystalline repository project. Patera, E.S. (Argonne National Lab., IL (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

The US Department of Energy Crystalline Repository Project (CRP) is mandated by the NWPA to design and site candidates for the nations second high-level radioactive waste repository. The CRP is currently screening from 236 rock bodies to 12 preliminary proposed acceptable sites (dARR). The CRP is also involved in technology development and demonstrates, both domestically and internationally. These include a cooperative agreement with Atomic Energy of Canada Ltd. to work at their field research areas and the Underground Research Laboratory, and the Stripa International Project in Sweden. The data derived from the field characterization and the technology development will be used to design the repository system beginning FY 1987.

27154 Geochemical behavior of radionuclides in a nuclear waste repository in basalt. Barney, G.S. (Rockwell Hanford Operations, Richland, WA (USA)). pp. 44 of American Chemical

Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

The long-term safety of a nuclear waste repository in basalt depends on the geochemical behavior of waste radionuclides. Potential releases of these radionuclides from the repository via ground flow involve the following chemical processes: (1) dissolution of radionuclides from the waste form, (2) precipitation, (3) redox reactions, (4) sorption reactions with geologic solids and engineered barriers, and (5) formation of complex chemical species. The extents and rates of these reactions must be evaluated and integrated with physical and hydrologic parameters (such as diffusion and hydrodynamic dispersion coefficients) to predict radionuclide transport along probable groundwater flow paths. The chemical behavior of some radionuclides in the expected environment of groundwater flow paths have been investigated. These are radioactive isotopes of elements that are considered to be important to long-term repository performance (americium, plutonium, neptunium, uranium, iodine, carbon, technetium, selenium, and others). A summary of current information on reactions of these elements in a basalt environment is presented.

27155 Natural radionuclide behavior in Hanford site groundwaters. Smith, M.R. (Pacific Northwest Labs., Richland, WA (USA)); Laul, J.C.; Johnson, V.G. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Investigations of natural radionuclides of the uranium and thorium decay chains in site-specific groundwaters can provide direct and analog information on the expected behavior of radwaste radionuclides in groundwaters. In addition, the natural radionuclide concentrations can provide baseline information for future monitoring purposes. Their study of basalt groundwaters at the Hanford site shows that the concentrations of U, Th, Ra, Pb, and Po are extremely low relative to local springs and surface waters. The radionuclides of U, Th, and Ra appear highly sorbed. Relative to Rn, in situ retardation factors for U, Th, and Ra range from 10^3 to 10^4. Colloids appear important for Pb and Po, but not for U, Th, and Ra.

27156 Natural analogs: Application to prediction of long-term radionuclide isolation in a nuclear waste repository in basalt. Burnell, J.R. (Rockwell Hanford, Richland, WA (USA)); Grandstaff, D.; Cummings, M. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Rockwell Hanford Operations is conducting research for the US Department of Energy to assess the suitability of the Hanford Site, WA, for permanent geologic disposal of high-level nuclear waste. The research includes prediction of radionuclide mobility in the event of groundwater interaction with the waste form. Laboratory experiments are proceeding to define the interactions among the waste form, groundwater, and other components of the engineered barriers system. Limited radionuclide mobility should result as these species are incorporated into solid phases formed by synergistic reactions among these components. Metastability of phases can be a problem in interpreting 6-12 month tests. However, the system simulated in the laboratory is analogous to hydrothermal systems common in the earths crust. They are currently investigating both fossil and active geothermal systems to compare with experiments and computer models of hydrothermal system evolution. The dominant geochemical control will be exerted on the system by the basalt rock of the repository; hence natural analogs of hydrothermal systems in basalt are being used - one, the active geothermal systems of Iceland, the second, a fossil geothermal system in NE Oregon.

27157 Effect of ionizing radiation on radionuclide speciation: Preliminary results from site-specific experiments in a basaltic system. Reed, D.T. (Rockwell Hanford Operation, Richland, WA (USA)); Burnell, J.R. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Rockwell Hanford Operations, under contract to the Department of Energy, is investigating the suitability of the Hanford site in the state of Washington as a high level nuclear waste repository. An important consideration in these investigations is the effect of ionizing radiation on the speciation of radionuclides in the groundwater after the high-level-waste container has been breached and there is direct contact between the groundwater and the waste form (controlled released period). The effect of ionizing radiation on radionuclide speciation depends on the radiation environment and site-specific chemistry near the waste container. With respect to these two aspects, the following results will be presented: a definition of the radiation environment during the controlled release period; preliminary site-specific experimental results: (1) basaltic systems spiked with radionuclides; (2) spent fuel-groundwater-basalt experiments.

27158 Hydrochemistry in the development of groundwater flow models at the Hanford site. Early, T.O. (Rockwell Hanford Operations, Richland, WA (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Site characterization activities in progress at the Hanford Site include efforts to understand the groundwater flow regime within the Columbia River Basalt Group. Hydrochemical data from deep boreholes at Hanford suggest that groundwater has migrated upward at an unknown rate from the underlying sediments and mixed with more dilute shallow groundwaters within basalt aquifers. The driving force for upward flow is hypothesized to result from a regional flow system. Detailed analysis of deep groundwaters indicates that two major types exist. For example, water underlying the western part of the Site are sulfate poor and associated with relatively abundant dissolved methane. Deep groundwaters of the second type, lying to the east, are relatively sulfate rich but contain essentially no methane. Specific features of the source regions that yield these different geochemical types are poorly known but association of the western waters with methane-producing coal strata is proposed. At the level of the proposed repository evidence seems to point to little lateral flow. At shallower depths a somewhat more active lateral flow system is possible. The direction of lateral flow, whatever its rate, appears to be structurally controlled.

27159 Groundwater age dating at the Hanford site. Johnson, V.G. (Rockwell Hanford Operations, Richland, WA (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Groundwater age dating methods based on ^{14}C, noble gas isotopes and ^{36}Cl are under evaluation at the Hanford Site to aid in describing the pre-existing hydrologic regime and to estimate paleo-transport rates. Carbon-14 methods currently in use are limited to relatively young (<30,000 yr) groundwater from shallow aquifers. Groundwater from basalt aquifers beneath the candidate horizon appear to be very old (10^5 to 10^6 years), based on interpretation of preliminary noble gas and ^{36}Cl data. Depth profiles of ^{36}Cl and noble gas isotopes (^3He, ^4He, ^{20}Ne, ^{36}Ar, and ^{40}Ar) near the proposed repository location are being obtained to assess mixing and flow dynamics of hypothesized vertical flow.

27160 The role of mineralogic studies in the geochemical evaluation of nuclear waste isolation. Horton, D.G. (Rockwell Hanford Operations, Richland, WA (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Mineralogic studies provide useful input for understanding possible rock/water/nuclear waste interactions and the stability of present and future geochemical environments which may be associated with a high level, nuclear waste repository. Minerals precipitated from groundwater in the Rocky Coulee and Cohassett

flow tops in the Grande Ronde Formation, Columbia River Basalt Group, central Washington include two or more compositionally different smectites, two celadonites, clinoptilolite, opal-C, opal-CT, quartz, pyrite and calcite. The clays, zeolite, and silicas are the most abundant and widespread secondary phases; pyrite and calcite are minor in abundance and distributed sporadically. Based on petrographic observations, the general paragenetic sequence is smectite - clinoptilolite - smectite - calcite. Most silica is younger than clinoptilolite but some silica predates clinoptilolite. The mineralogic, geochemical, and paragenetic observations can be incorporated in models which predict rock/water/nuclear waste interactions. For example, the reaction products from computer generated rock/water interaction models (EQ3/6) show similar paragenetic sequences to those observed in the rock.

27161 Geologic framework of Yucca Mountain, Nevada. Scott, R.B. (Geological Survey, Denver, CO (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465--: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Yucca Mountain is the eroded, faulted, and tilted remnant of a 13-m.y.-old volcanic plateau. Strata consist of alternating welded and nonwelded silicic tuffs 1 to 6 km thick above Paleozoic rocks. One 300-m-thick welded tuff in the Paintbrush Tuff is the host rock for a potential nuclear waste repository. In contrast to welded tuffs in the Paintbrush, underlying tuffs of Calico Hills are nonwelded and partially zeolitized. Typically, brittle densely welded tuffs contain about 30 fractures/m^3, but ductile nonwelded tuffs contain <3 fractures/m^3. Structures are typical of Great Basin extensional terranes. Major west-dipping normal faults (> 100 m offset) have broken the plateau into blocks with 5 to 50° eastward stratigraphic dips. Within blocks, minor west-dipping normal faults (< 10 m offset) are common. Increases in normal fault abundance and tilt of strata suggest increased extension southward. Paleomagnetic evidence requires 30° of clockwise, vertical axis rotation from north to south. Regional tectonic relations suggest Yucca Mountain is detached along low-angle faults at shallow crustal levels.

27162 Ground-water travel time calculations for the potential nuclear repository site at Yucca Mountain, Nevada. Younker, J.L. (SAIC, Las Vegas, NV (USA)); Wilson, W.E.; Sinnock, S. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465--: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

In support of the US Department of Energy Nevada Nuclear Waste Storage Investigations Project, ground-water travel times were calculated for flow paths in both the saturated and unsaturated zones at Yucca Mountain, a potential site for a high-level radioactive waste repository in southern Nevada. The calculations were made through a combined effort by Science Applications International Corporation, Sandia National Laboratories, and the US Geological Survey. Travel times in the unsaturated zone were estimated by dividing the flow path length by the ground-water velocity, where velocities were obtained by dividing the vertical flux by the effective porosity of the rock types along assumed vertical flow paths. Saturated zone velocities were obtained by dividing the product of the bulk hydraulic conductivity and hydraulic gradient by the effective porosity. Total travel time over an EPA-established 5-km flow path was then calculated to be the sum of the travel times in the two parts of the flow path. Estimates of ground water fluxes and travel times are critical for evaluating the favorability of the Yucca Mountain site because they provide the basis for estimating the potential for radionuclides to reach the accessible environment within certain time limits.

27163 Mineralogic studies of tuff for high-level waste disposal. Vaniman, D. (Los Alamos National Lab., NM (USA)); Bish, D.; Broxton, D.; Byers, F.; Carlos, B.; Levy, S. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465--: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

The volcanic rocks at Yucca Mountain, Nevada, consist predominantly of tuff that originated 12 to 14 million years ago as flows and airfalls of hot volcanic particulates. On cooling these units formed two major rock types: crystallized zones formed mostly of feldspar and silica minerals, and zones of glass. Alteration of glass to zeolite minerals occurred largely during structural tilting of Yucca Mountain in the ~1-3 million years following the major eruptions. The compositions of zeolites formed from glasses strongly indicate open-system chemical exchange. Superimposed on this general alteration of glasses are areas of local high-temperature alteration. High-temperature alteration ended by 11 million years ago. Zeolites such as clinoptilolite persisted during high-temperature alteration at temperatures up to 100°C, suggesting that clinoptilolite at Yucca Mountain close to the thermally disturbed zone around a repository may also survive heating to temperatures at least this high. The mineralogic data from tuff at Yucca Mountain will ultimately be used by the Department of Energy Nevada Nuclear Waste storage Investigations for (1) defining the mineralogic component in estimating waste element travel times away from the repository and (2) determining the past history of alteration and the anticipated stability of minerals near the repository.

27164 Geochemical processes affecting the transport of radionuclides in Yucca Mountain. DePoorter, G.L. (Los Alamos National Lab., NM (USA)); Cederberg, G.A. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465--: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Licensing a high-level nuclear waste repository requires calculations of radionuclide transport from the waste package to the accessible environment to assure compliance with NRC and EPA regulations. Site specific definitions of hydrologic, geologic, mineralogic, and geochemical processes and their associated parameter values are required for these calculations. This paper describes the significant geochemical processes at Yucca Mountain and their effects on the transport and retardation of radionuclides. From ongoing investigations, the important geochemical processes identified are sorption, matrix diffusion, and precipitation. In addition, colloid or particulate and vapor phase transport will be described. The effects of geochemical processes on transport will be shown by examples of integrated calculations using the TRACR3D transport code.

27165 Transport of radionuclides through fractures: Effects of channeling. Rundberg, R.S. (Los Alamos National Lab., NM (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465--: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Results from laboratory studies of radionuclide migration through natural tuff fractures do not agree with simple matrix diffusion models of transport through fractures. Although much of the tracer is retained in the rock matrix, a small pulse of adsorbing tracer is eluted at an earlier retention volume than expected. The size and shape of this pulse can not be reproduced by simply reducing the distribution coefficient or adjusting the diffusivity. Nonsorbing tracers, on the other hand, are in reasonable agreement with the matrix diffusion model. Early arrival of adsorbing tracers can be described by including channeled flow in the transport model. Channeling is caused by the irregular surface texture of the fractures. Recent mathematical developments using fractal geometry allow the modeling of rough surfaces and irregular flow patterns. This talk will discuss (1) the evidence for channeling in fracture flow, (2) the evidence for the fractal nature of fracture surfaces, and (3) the consequences of fractal geometry to predicting radionuclide migration on the field scale.

27166 In situ geochemical measurements in the exploratory shaft at Yucca Mountain. Norris, A.E. (Los Alamos National Lab., NM (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465--: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Two tests have been proposed by Los Alamos for the Exploratory Shaft at Yucca Mountain to determine, under in situ conditions, the values of geochemical parameters that will be used to assess the performance of a possible nuclear waste repository in the vadose zone. One test will measure diffusion of nonsorbing tracers into the water-filled pores of tuffs at the repository level and below. The diffusivity coefficients derived from the data will be incorporated into transport code calculations that determine the effects of diffusion in retarding the movement of TcO_4^- and I^- under aqueous flow conditions. The second test will measure ^{36}Cl in tuff samples collected as the Exploratory Shaft is mined. The radioactive decay of ^{36}Cl will be used to measure the rate of water movement through the vadose zone over longer times than could be measured by the conventional ^{14}C method. Measurements of ^{36}Cl in soil samples from Yucca Mountain already have helped trace infiltrating precipitation.

27167 Interaction of rock, water, container material, and waste forms under conditions expected for a repository in the unsaturated zone at Yucca Mountain. Oversby, V.M. (Lawrence Livermore National Lab., CA (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract W-7405-ENG-48. (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Emplacement of waste packages in a repository at Yucca Mountain would cause changes in the temperature of the rock. These changes would then cause alteration in the moisture content of the rock pores and the chemistry of the water in the pores. Laboratory experiments are being conducted to determine the water chemistry after reaction of the rock with pore water at the post emplacement temperatures. Corrosion of metal container materials and degradation of spent fuel and borosilicate glass waste forms are then investigated as a function of possible water chemistry and temperature regimes. The goal of this work is to define the relationship of corrosion and waste form degradation processes and rates to the possible range in water chemistry for the repository under the range of anticipated and possible, but unanticipated, conditions.

27168 Geochemical modeling of the interactions of water with rock and other repository materials. Wolery, T.J. (Lawrence Livermore National Lab., CA (USA)); Delany, J.M.; Bourcier, W.L. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract W-7405-ENG-48. (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Geochemical modeling capabilities are being developed in the EQ3/6 computer code package to aid in interpreting and extrapolating the results of field studies and low temperature and hydrothermal experiments in water/rock systems and in aqueous systems containing other repository components such as waste forms. Specific goals include elucidating controls on changes in fluid composition and the formation of secondary phases, relating experimental results to basic thermodynamic and kinetic data, and extrapolating to different conditions (including sensitivity studies) and to longer times. These are illustrated by recent success in real-time reaction path modeling of an experiment reacting devitrified tuff with J-13 well water at 150°C, followed by extrapolations in both reaction conditions and time. Further work of this kind will require additional thermodynamic and kinetic data.

27169 Estimates of cumulative releases of radionuclides to the water table from a repository at Yucca Mountain, Nevada. Tierney, M.S. (Sandia National Labs., Albuquerque, NM (USA)); Bingham, F.W. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Expected cumulative releases of radioactivity to the water table under a nuclear waste repository at Yucca Mountain, Nevada, are estimated for a period of 10,000 years after closure of the repository using a simple mathematical model which incorporates ideas of Simmons, a ground-water travel time distribution based on a hydrologic model of the sites unsaturated zone, and measured sorption ratios of the radionuclide species in Yucca Mountain water chemistry. Only non-sorbing species, C-14, I-129, and Tc-99, are released in the 10,000 period from a repository containing 70,000 MTU of spent fuel; the cumulative release is estimated to be about one ten-millionth of the release limit allowed in the applicable standard governing long-term containment of nuclear wastes in a geologic repository.

27170 Disequilibrium study of natural radionuclides in groundwaters. Laul, J.C. (Pacific Northwest Lab., Richland, WA (USA)); Smith, M.R. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Disequilibrium study of natural radionuclides of the Uranium and Thorium decay series in site-specific groundwaters can provide direct and analog information on the expected behavior of radwaste radionuclides in groundwaters. Their study of natural radionuclides in briney groundwaters from the Palo Duro Basin shows that Radium is not sorbed and thus not retarded in deep brines. Relative to Radium, the radionuclides of U, Th, Pb, Bi, and Po are highly retarded by sorption. The retardation factors for ^{230}Th and ^{234}U range from 10^3 to 10^5. The $^{234}U/^{230}Th$ ratio can be used as an indicator of redox state of the aquifers environment. Colloids do not appear important in the transport of U, Th, and Ra radio nuclides in brines. The natural radionuclide spectrum in brines appears characteristic of the nature of the source region.

27171 Geochemical sensitivity analysis: identification of important geochemical parameters for performance assessment studies. Siegel, M. (Sandia National Labs., Albuquerque, NM (USA)); Guzowski, R.; Rechard, R.; Erickson, K. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract AC04-76DP00789. (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

The EPA Standard for geologic disposal of high level waste requires demonstration that the cumulative discharge of individual radioisotopes over a 10,000 year period at points 5 kilometers from the engineered barrier system will not exceed the limits prescribed in 40 CFR Part 191. The roles of the waste package, engineered facility, hydrogeology and geochemical processes in limiting radionuclide releases all must be considered in calculations designed to assess compliance of candidate repositories with the EPA Standard. In this talk, they will discuss the geochemical requirements of calculations used in these compliance assessments. In addition, they will describe the complementary roles of (1) simple models designed to bound the radionuclide discharge over the widest reasonable range of geochemical conditions and scenarios and (2) detailed geochemical models which can provide insights into the actual behavior of the radionuclides in the ground water. Finally, they will discuss development of sensitivity/uncertainty techniques designed to identify important site-specific geochemical parameters and processes using data from a basalt formation.

27172 Obtaining reasonable assurance on geochemical aspects of performance assessment of deep geologic repositories. Van Luik, A.E. (Battelle, Pacific Northwest Labs., Richland, WA (USA)); Serne, R.J. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract AC06-76RL01830. (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Providing reasonable assurance that a deep geologic disposal system will perform as required by regulation involves, in part, the building of confidence by providing a sound scientific basis for the site characterization, engineered system design, and system performance modeling efforts. Geochemistry plays a role in each of these activities. Site characterization must result in a description of the in situ geochemical environment that will support the design of the engineered system and the modeling of the transport of specific radionuclides to the accessible environment. Judging the adequacy of this site characterization effort is a major aspect of

providing reasonable assurance. Within site characterization, there are a number of geochemical issues that need to be addressed such as the usefulness of natural analog studies, and assessing the very long-term stability of the site geochemistry, given expected temperature and radiation conditions.

27173 **Performance assessment of high-level nuclear waste repositories: Can K_d's represent geochemical reality?.** Tripathi, V.S. (Oak Ridge National Lab., TN (USA)); Yeh, G.T.; Jacobs, G.K.; Kelmers, A.D. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Numerous studies suggest, explicitly or implicitly that K_d's can be successfully used to model the transport of radionuclides away from proposed nuclear waste repositories as part of performance assessment calculations. Indeed, most ongoing experimental investigations of radionuclide retardation rely exclusively on the K_d, or at best the sorption isotherm, approach in systems thought to be representative of potential sites. The assumption that low (but nonzero) K_d values for all radionuclides may provide conservative estimates by underestimating the extent of contaminant retardation may not be correct for all geochemical settings. While acquiring perfect geochemical understanding of relevant systems may be neither necessary nor practical for designing repositories, it is certainly advantageous to investigate the extent to which K_d-based calculations may be good enough for performance assessment. The results of geochemical and hydrogeochemical simulations employing the K_d approach and a comprehensive approach explicitly accounting for geochemical processes for several selected scenarios will be presented. The intent of the simulations is to present enough quantitative information to allow context-specific decisions by the audience as to whether K_d would be acceptable. The results in general are applicable to a variety of candidate sites; however, specific examples are limited to tuff systems.

27174 **Organic geochemistry of subsurface transport of radionuclides at waste disposal sites.** Toste, A.P. (Pacific Northwest Lab., Richland, WA (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract AC06-76RL01830. (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

The factors governing the subsurface transport of radionuclides in soil solutions can be quite varied and complex. Their group has studied the role of organics in mediating radionuclide transport at several shallow-land burial sites of low-level nuclear waste. Hydrophilic organics and, to a less extent, hydrophobic organics can be leached from unconsolidated wastes by groundwater. In general, the soil at the various sites efficiently sorbs most of the radionuclides, e.g. { >=} 98%. However, small amounts of certain radionuclides appear to migrate as anionic complexes, some of which appear to be organoradionuclides. At certain sites waste-derived organics, e.g. chelating agents, appear to dominate the organic-mediated transport; at other sites, naturally-occurring organics, e.g. humic and fulvic acids, appear to dominate. At some disposal sites, site-specific groundwater and soil properties, e.g., Eh and pH, appear to mitigate against any organic-enhanced mobility.

27175 **Rare earth patterns in briney aquifers from the Palo Duro basin.** Laul, J.C. (Pacific Northwest Labs., Richland, WA (USA)); Lepel, E.A. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

The rare earth element (REE) patterns in site-specific groundwaters can be used as in situ tracers to characterize the nature of the source region. The authors studied the REE in briney aquifers from Granite Wash (GW), Pennsylvania Granite Wash (PGW), and Wolfcamp Carbonate (WC) formations of the Palo Duro Basin. The REE concentrations range from μg/l to ng/l in these brines. The chondritic normalized REE patterns are highly fractionated from light REE to heavy REE. The GW brine has the highest REE content and shows a negative Eu anomaly with La/Lu ratio of 7.9. The PGW and WC brines exhibit a positive Ce (Ce^{+4}) anomaly, similar to that observed in sea water. The chondrite normalized La/Lu ratio for PGW brine is 11.0, while that of WC is 5.5. The REE patterns in brines appear characteristic of their source regions. The unique REE patterns of each source region do not indicate apparent mixing of brines among the formations.

27176 **Measured and extrapolated values of solubility products of tetravalent actinide hydrous oxides.** Rai, D. (Pacific Northwest Lab., Richland, WA (USA)); Swanson, J.L.; Ryan, J.L. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Copper(I)/Copper(II) redox buffer was tested for use in studying $NpO_2 \times xH_2O$(am) solubility and was found to be stable with time and to equilibrate rapidly with the Np species. The solubility of $NpO_2 \times xH_2O$ was therefore studied in the presence of Cu(I)/Cu(II) buffer (0.001 M $CuCl_2$ and CuCl, and 0.01 M NaCl) and in a pH range of 1.5 to 2.5. Adequate concentrations of buffer species (Cu(I) and Cu(II)) ensured that the measured redox potentials accurately reflected the equilibrium. Based on the measured redox potentials, pH, and calculated activities of Np^{4+} and NpO_2^+, the thermodynamic equilibrium constants at room temperature were determined for the following reactions: $NpO_2 \times xH_2O \rightleftharpoons Np^{4+} + 4OH^- + (x - 2)H_2O$ (log $K_{sp} = -54.5 \pm 0.3$) $NpO_2 \times xH_2O \rightleftharpoons NpO_2^+ + e^- + xH_2O$ (log $K° = -8.16 \pm 0.12$). The experimental log K_{sp} values of Th(IV), Np(IV), and Pu(IV) hydrous oxides show a linear relationship with the inverse square of the M^{4+} ionic radii. Therefore, it is possible to reliably estimate the log K_{sp} values for other tetravalent actinide hydrous oxides as well. These estimated log K_{sp} values are −52.6 for U(IV), −50.6 for Pa(IV), −58.0 for Am(IV), and −59.1 for Cm(IV) hydrous oxides.

27177 **Stability of the perovskite $BaPuO_3$, a model nuclear-waste material.** Morss, L.R. (Argonne National Lab., IL (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). DOE Contract W-31109-ENG-38. (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

The enthalpy of formation of $BaPuO_3$ at 298.15 K has been determined by solution microcalorimetry to be $-1{,}656.0 \pm 5.6$ kJ mol^{-1}. The $\Delta H°$ of solid-state complex formation at 298.15 K, $BaO(s) + PuO_2(s) = BaPuO_3(s)$, has been calculated to be -51.8 ± 5.7 kJ mol^{-1}. These results are compared with those for other f-element dioxides and ternary (perovskite) oxides and are used to estimate thermodynamic properties for potential dissolution reactions in a nuclear waste repository. The results indicate that the perovskite structure is not suitable for immobilization of plutonium unless reducing (oxygen-free) conditions are maintained.

27178 **Natural analogue studies: Real world answers for nuclear waste questions.** Levich, R.A. (Dept. of Energy, Argonne, IL (USA)); Patera, E.; Shea, M.; Yates, K.; Brandstetter, A. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Natural analogue studies are perceived by the US and international nuclear waste communities as being an integral part of any verifiable understanding of processes and materials which affect radioactive waste isolation. A natural analogue can be defined as a study of long-term natural phenomena which gives insight, either qualitatively or quantitatively, into the expected processes related to radioactive waste isolation. Natural analogues will play three important roles; regulatory, technical, and public confidence. This includes repository siting and licensing, evaluation of engineered components, definition of site characterization data of engineered components, definition of site characterization data needs, improvement of the understanding of radwaste isolation concerns and

capabilities, and validation of performance assessment models and their credibility.

27179 Pegmatite/wallrock interaction: Natural analog for high-level waste isolation. Shearer, C.K. (South Dakota School of Mines and Technology, Rapid City (USA)); Papike, J.J.; Laul, J.C. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Exsolution of a fluid phase during crystallization of a volatile-rich pegmatite melt provides a medium for fluid transport of relatively incompatible elements out of the pegmatite system and into surrounding country rock. Interaction between pegmatite-derived fluids and country rock results in the formation of extensive exomorphic aureoles. Such contact metamorphic occurrences serve as geologic analogs for the underground storage of nuclear waste, with the igneous intrusion providing the heat and trace element source, and the surrounding country rock the medium through which migration takes place. This type of study provides information of chemical migration over geologic time, a time span that cannot be duplicated in laboratory experiments or with presently available calculation procedures.

27180 Marysvale natural analog study: Results of Phase I. Shea, M. (Battelle Office of Crystalline Repository Development, Columbus, OH (USA)); Foland, K.A. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

The Marysvale Natural Analog Study is being conducted by the Office of Crystalline Repository Development for the US Department of Energy. The major focus of this study is the elucidation of the mass transport of nuclides in a fossil hydrothermal system associated with some uranium (uraninite-pyrite-fluorite) veins within quartz monzonite and granite in central Utah. The objectives of the study include: determining the nature of the mineralizing hydrothermal system in terms of thermal, spatial, temporal, and chemical parameters; determining the extent of the element/fluid migration; and, identifying the geochemical and geomechanical processes controlling this movement. Chemical, isotopic, age, and petrographic studies indicate: the cooling ages of the two intrusives are similar (~23 m.y.); the hydrothermal fluids were derived from meteoric water; water/rock ratios for the quartz monzonite range widely, up to a value of one for an apparent fluid temperature of 200°C; fluid movement was highly controlled by fractures; the quartz monzonite/granite contact apparently allowed enhanced passage of solutions; and, significant recent modification is implied by uranium-series disequilibrium.

27181 Field geochemistry in the crystalline repository program: Area phase status and future plans. Melchior, D. (Earth Technology Corp., Long Beach, CA (USA)); Shea, M. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

The geochemical environment in crystalline rock is expected to differ from that present in other potential radioactive waste repository host media. In the CRP, igneous and metamorphic host rocks are being considered in 12 proposed Potentially Acceptable Sites (PASs). In order to appropriately characterize the host media, a conceptual mode of the anticipated geochemical environments will be in each proposed area developed. Prior to commencing field work, the area phase geochemistry field program is being designed to optimize sample quality through office-based scoping studies, followed by designing and testing methods for drilling, sampling, and analysis in conjunction with the Canadian radioactive waste program. Mobile field labs, down-hole samplers, and in-line multiple parameter analysis techniques will be used to assure accuracy. In the field, aqueous geochemical computer analysis will be used to assess sample quality. Geochemical data will provide required information for input to an overall performance assessment model.

27182 An integrated approach to isotopic study of crystalline rock for a high-level waste repository: Area phase. Gilbert, L.A. (Earth Technology Corp., Long Beach, CA (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

An integrated approach to assessing isotopic systems in crystalline rock is planned for area phase studies. This approach combines radiogenic isotope systems with petrography in order to characterize potential crystalline repository media. The coeval use of selected isotope systems will minimize the limitations of each method and provide intensive parameters yielding data on alteration timing, secondary mineral formation, temperature history, and radionuclide species migration. Isotope systems will be selected in order to measure differences in sensitivity to thermal disturbances and mobility due to fluid interaction. Comparative evaluation of isotope pair behavior may be used in combination with mineral versus whole-rock dates to provide data on heating and mobilization of alkali elements, lanthanides, and gases, caused by future introduction of waste.

27183 The effect of dissolved organic matter upon potential radionuclide solubility in crystalline rock groundwater. Glazier, R.M. (Earth Technology Corp., Long Beach, CA (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

Groundwater flow is considered to be the primary mode of radionuclide transport from a water saturated high level waste repository site. Radionuclide solubilities will be influenced by both the inorganic and organic chemistry of the groundwater. This groundwater is expected to have differing types and concentrations of dissolved organic matter, which may complex radionuclides through oxygen, sulfur-, and nitrogen-containing functional groups. Possible ligands include carboxylic acid anions, amines, amino acids (in the Zwitterion form), mercaptans, heterocyclic compounds (including carbohydrates, porphyrins, lignin, humic and fulvic acids), and alpha-ketoacids. Humic and fulvic acids may be the dominant type of organic matter in crystalline rock as these are the dominant organic products of degradation of soil organic matter. Because of competing ion effects, complexing with both radionuclides and indigenous inorganic ions must be addressed.

27184 The molybdenum solar neutrino experiment. Schroeder, N.C. (Los Alamos National Lab., NM (USA)); Wolfsberg, K.; Curtis, D.B.; Ogard, A.E.; Rokop, D.J.; Cappis, J.H.; Bryant, E.A.; Cowan, G.A.; Haxton, W.C. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609464–: American Chemical Society Division of Nuclear Chemistry and Technology, Anaheim, CA (USA), 7-12 Sep 1986).

The molybdenum solar neutrino experiment will probe the time-averaged neutrino flux during and before the Pleistocene epoch through the measurement of ^{98}Tc produced by neutrino reactions on ^{98}Mo. It is estimated that 10,000 tons of molybdenum ore from the deeply buried Henderson deposit will contain 10^8 atoms of ^{98}Tc. Technetium is separated from the ore by absorbing it from the acid-scrub stream of a commercial molybdenite roasting plant. For each technetium measurement the oxidized scrub stream (113L/min) is passed through large beds of anion exchange resin. Prior to ashing the resin, coabsorbed molybdenum is removed using a NaCl/NaOH eluent. Solvent extraction and ion exchange techniques are used to purify the technetium from rhenium and residual molybdenum. Both positive and negative thermal ionization mass spectrometric techniques have been developed to analyze technetium at the 10^8 atom level.

27185 Separation of tracer titanium-44 from vanadium. Sajjad, M. (Brookhaven National Lab., Upton, NY (USA)); Lambrecht, R.M. pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609464–: American Chemical

Society Division of Nuclear Chemistry and Technology, Anaheim, CA (USA), 7-12 Sep 1986).

The trend in radiopharmaceutical research and development is towards the use of short-lived neutron deficient nuclides. Biomedical generators that deliver positron-emitting nuclides will be an important source of these nuclides. The $^{44}Ti/^{44}Sc$ generator [$^{44}Ti(t_{\frac{1}{2}}$ = 47Y), $^{44}Sc(t_{\frac{1}{2}}$ = 3.39h)] has been proposed for studying bone diseases by positron emission tomography. $^{46-47}Sc$ has been suggested as a potential scanning agent for tumor, bone marrow and for metabolism studies. The authors have found that ^{44}Ti can be produced by the $^{51}V(p,2p,6n)^{44}Ti$ nuclear reaction by irradiating a vanadium target with high energy protons. They have developed a new method for the separation of titanium from Vanadium. Tatanium and Vanadium were converted to valence of plus four. Titanium was bound to fluoride as TiF_6^{2-}. The solution was passed through anion-exchange column using 0.1 M HCL-1 M HF as the eluant. The decontamination factor for Vanadium was 4.0×10^5.

27186 **Strategy for determination of geochemical reactivity in the Hanford basalts, southeastern Washington.** Wallick, E.I. (Rockwell Hanford Operations, Richland, WA (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609465–: Symposium on geochemical aspects of radioactive waste disposal, Anaheim, CA (USA), 7-12 Sep 1986).

The geochemical reactivity of radionuclides or their analogues will be determined in basalt groundwater systems at the Hanford Site to assess its suitability for permanent disposal of high level radioactive waste. A combination of field and laboratory experiments are being designed to determine radionuclide sorption, kinetics of redox reactions, and retardation factors in basalt from a repository. Field testing requires that both single and paired borehole reactive tracer tests be carried out in basalt flow tops at a depth of about 1,000 meters. Special precautions are required to prevent atmospheric contamination of the borehole fluids which could affect the validity of results. Laboratory batch and column sorption testing on core materials collected before and after field tracer testing will be conducted to determine scale factors between laboratory and field sorption data obtained for a variety of key radionuclides.

6511 Experimental Techniques

Refer also to citation(s) 27098, 27099, 27100, 27101, 27102, 27103, 27104, 27105, 27107, 27109, 27184, 27185, 27255

27187 (FRCEA-TH–210) **Production of high energy gamma rays in the proton-nucleus and nucleus-nucleus reactions at intermediary energy.** Kwato Njock, M.G. CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Recherche Fondamentale; Grenoble-1 Univ., 38 (France). 1988. 265p. (In French). Order Number DE90770338. Available from NTIS (US Sales Only), PC A12/MF A01.

We have developed an experimental set-up for the detection of gamma rays above 20 MeV energy, produced in nuclear reactions at intermediate energies. This detection system was calibrated with tagged photons at the Saclay linear accelerator. Several inclusive experiments have been carried out at SARA, GANIL, S.C. CERN, SIN, S.C. ORSAY, with ^{40}Ar, ^{86}Kr, ^{12}C, ^{36}Ar of 30, 44, 84, 85 MeV/u respectively, and protons of 72, 168, 200 MeV, impinging on various targets from carbon to gold. We have also studied the photons produced in coincidence with the charged particles in the $^{36}Ar + ^{27}Al$ reaction at 85 MeV/u. A qualitative analysis of the characteristics of the gamma emission suggests strongly that the initial proton-neutron collisions are the main source of this electromagnetic radiation. The theoretical models which have been put forward to understand the production mechanism of these gamma rays are presented, and their predictions are compared with the available data.

27188 (GANIL-P–89-14) **The mass and radius of exotic fragment.** Schutz, Y. Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France). 1989. 17p. Order Number DE90770330. Available from NTIS (US Sales Only), PC A03/MF A01.

Recent developments in the study of exotic nuclei are presented. A method to measure the ground-state mass is presented and the results are compared with standard models. Total reaction cross section measurements for exotic nuclei are also presented and interpreted in terms of matter distribution in the nucleus.

27189 (LA-UR–90-1035) **Gamma-ray production cross section measurements using a white neutron source from 1 to 400 MeV.** Wender, S.A.; Nelson, R.O.; Laymon, C.M. Los Alamos National Lab., NM (USA). [1990]. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-9002109–1: Specialists' meeting on measurement, calculation and evaluation of photon production cross sections, Smolenice (Czechoslovakia), 5-7 Feb 1990). Order Number DE90008906. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The continuous energy (white) neutron source at the Los Alamos Meson Physics Facility (LAMPF) is used to measure photon-production cross sections over a wide range of neutron energies. Detector systems have been or are being developed to measure gamma rays in the energy range from hundreds of keV up to several hundreds of MeV. In particular a high resolution Ge detector system is used to detect gamma rays from several hundred keV to over 6 MeV. A 5 crystal BGO detector system is used for measuring gamma-rays from 1 MeV to approximately 20 MeV. A large volume BGO detector with an active shield is used to measure gamma rays in the range from 5 to 40 MeV. We are presently developing a multi-element gamma-ray telescope to measure gamma rays with energies from 50 MeV up to several hundred MeV.

6514 Nuclear Properties and Reactions, A = 20-38, Experimental

Refer also to citation(s) 27193

27190 (OUP–90-04) **Comments on leading mesons in anti p Ne - reactions at 607 MeV/c incident momentum in terms of four-momentum transfers in two-vertex diagrams.** Breivik, F.O. (Oslo Univ. (Norway). Fysisk Inst.); Haatuft, A.; Halsteinslid, A. LEAR Collaboration. Oslo Univ. (Norway). Fysisk Inst. Feb 1990. 9p. Project CERN-PS-179. Order Number DE90622669. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Based on previous observations of anti p Ne - reactions the author discuss, in terms of four-momentum transfers, why only leading pions are seen in events detected by their Λ-decays, and only leading kaons in the events detected by their neutral K-decays. The experimental results are consistent with a two-vertex model with strange or non-strange baryon exchange. 3 refs.; 4 figs.; 1 tab.

6515 Nuclear Properties and Reactions, A = 39-58, Experimental

Refer also to citation(s) 27193

27191 (DOE/ER/40293–4) **Nuclear structure studies via neutron interactions: Progress report, 1 July 1989–30 June 1990.** Carlton, R.F. Middle Tennessee State Univ., Murfreesboro, TN (USA). Dept. of Chemistry and Physics. Mar 1990. 35p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-86ER40293. Order Number DE90009470. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Research performed consisted of: refinement of previous analysis of high resolution total cross sections for $n + ^{40}Ar$ in an effort to remove some ambiguities in J^π assignments and completion of two papers dealing with this analysis and a comparison theoretical treatment of the associated scattering functions and R-functions; extension of the analysis of neutron total cross section data on ^{48}Ca to 3.5 MeV in neutron energy and modeling of the results with a dispersive optical model based on parameters from ^{40}Ca scattering data; attempted improvement of spin and parity assignments for data on ^{122}Sn and determination of external R-function parameters; development of a graphical interface, coupled with a code for calculation of R-matrix based total cross sections and parameter minimization, for an MS-DOS-based microcomputer. 11 refs., 13 figs.

27192 **Electromagnetic transitions in ^{43}K.** Moyers, K.R.L.; Bybee, C.R.; Kozub, R.L. *Journal of the Tennessee Academy of Science (USA)*, 63(1): 24 (Jan 1988). DOE Contract AS05-79ER10335.

Data on the level scheme of ^{43}K will be presented. The nucleus was populated via the ^{36}S (^{9}Be, pn)^{43}K reaction, and γ-rays were assigned to ^{43}K on the basis of coincidence with γ-rays already known to be in ^{43}K. Several previously unobserved γ-rays have tentatively been placed in the level scheme, and further analysis is proceeding. A brief discussion of other nuclei populated in this same reaction will be given, and plans for future analysis will be described.

6516 Nuclear Properties and Reactions, A = 59-89, Experimental

Refer also to citation(s) 27103

6517 Nuclear Properties and Reactions, A = 90-149, Experimental

Refer also to citation(s) 27191

27193 (IPNO-DRE–89-20) **Spin-flip ΔL = 0 transitions excited by proton inelastic scattering.** Marty, N.; Willis, A. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. 1989. 11p. Order Number DE90770340. Available from NTIS (US Sales Only), PC A03/MF A01.

In this talk the results obtained by (p,p') at Orsay on a heavy nucleus ^{90}Zr, a medium-heavy nucleus ^{48}Ca, will be recalled; data on even-even nuclei of the s-d shell will be discussed in more detail, very preliminary data obtained at Saturne on the main T = 1 and T = 0 states in ^{28}Si, at 200, 400, 600 MeV with a polarized beam will be given.

6518 Nuclear Properties and Reactions, A = 150-189, Experimental

Refer also to citation(s) 27196, 27201

27194 (IC–89/297) **Study of the non-yrast states in ^{152}Dy around 22(h/2π), the region into which the γ-rays drain in the superdeformed band.** Mansour, N. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 9p. Order Number DE90622683. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A detailed γ-ray study of ^{152}Dy emitted in decay of the superdeformed band has been performed using the ^{122}Sn(^{35}CL,P4n) reaction at low bombarding energy. Several γ-rays de-exciting non-yrast states have been identified, among them transitions previously observed in coincidence with this superdeformed band. We can also weakly detect the lowest two members of the superdeformed cascade, but the data are not quite good enough to make a firm connection to them. (author). 6 refs, 3 figs, 1 tab.

6519 Nuclear Properties and Reactions, A = 190-219, Experimental

Refer also to citation(s) 27104, 27105, 27201

27195 (BNL–44347) **Strangeness enhancement in 14.6 A GeV/c Si+Au interactions?.** Hansen, O. Brookhaven National Lab., Upton, NY (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900181–2: 18. international workshop of the gross properties of nuclei and nuclear excitations, Hirschegg (Austria), 15-20 Jan 1990). Order Number DE90008826. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The questions of strangeness enhancement and of J/ψ suppression have become central in the discussion of high energy heavy ion physics. Both phenomena have been predicted as signs of the formation of a deconfined quark-gluon phase of matter, both have been observed and both may be explainable also in terms of ordinary hadronic matter. In this note the question of K^+ and K^- enhancement will be discussed from a much less elevated point of view, namely as a question of enhanced (or suppressed) over what? What is the relevant comparison for $A_p + A_t$ data? 3 refs., 3 figs., 3 tabs.

27196 (DOE/ER/40346–3) **Studies of yrast and continuum states in A = 140–160 nuclei: Progress report for 1989.** Daly, P.J. Purdue Univ., Lafayette, IN (USA). Dept. of Chemistry. Jan 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER40346. Order Number DE90009484. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Nuclear structure investigations by γ-ray spectroscopy following heavy ion induced reactions are described. Recent results are summarized, with special emphasis on exotic new N-82 nuclei near the proton drip line, and on discrete superdeformed bands discovered in ^{190}Hg, ^{191}Hg and ^{192}Hg. 8 refs., 3 figs., 1 tab.

27197 (ORNL/FTR–3562) **[Two-phonon states involving giant resonances in ^{208}Pb]: Foreign trip report, January 27–March 3, 1990.** Beene, J.R.; Bertrand, F.E.; Halbert, M.L.; Horen, D.J.; Varner, R.L. Jr. Oak Ridge National Lab., TN (USA). 27 Mar 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008990. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The purpose of this foreign travel was to set up and perform an experiment designed to isolate, for the first time, two-phonon states involving giant resonances in ^{208}Pb. The GANIL laboratory, located in Caen, France, is the only facility in the world which can meet all the requirements imposed by this experiment at the present time. The experiment was carried out successfully, from a technical standpoint. Physics results will be known only after analysis of the data tapes. A meeting with a representative of the French government agency, Centre National de la Recherche Scientifique (CNRS), was held by one of the travelers to discuss future collaboration between French and ORNL physicists.

6520 Nuclear Properties and Reactions, A = 220 and Above, Experimental

Refer also to citation(s) 26276, 27099, 27100, 27101, 27102, 27112, 27113, 27127, 27128, 27129, 27201

27198 (LA-UR–90-988) **Level structure of ^{256}Fm: Experiment vs theory.** Bunker, M.E.; Starner, J.W. Los Alamos National Lab., NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-9004158–1: International conference on nuclear spectroscopy and shape of atomic nucleus, Leningrad (USSR), 10-13 Apr 1990). Order Number DE90008888. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The amount of experimental data on intrinsic states in the even-even isotopes of the transcurium elements is rather limited, providing only a few tests of theoretical models in this region. Thus, it is of interest to determine to what extent the recent results on levels in ^{256}Fm compare with existing theoretical calculations, such as those of Ivanova et al. 4 refs., 1 fig., 1 tab.

6530 Nuclear Theory

Refer also to citation(s) 27072, 27097, 27103, 27198

27199 (CONF-900295–2) **A one-body transport model of fluctuation processes in nuclear collisions.** Ayik, S. (Tennessee Technological Univ., Cookeville, TN (USA)); Gregoire, C.; Suraud, E.; Stryjewski, J.; Belkacem, M. Tennessee Technological Univ., Cookeville, TN (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-89ER40530. From 6. workshop on nuclear dynamics; Jackson Hole, WY (USA); 17-24 Feb 1990. Order Number DE90009317. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Many aspects of a many-body system can be described in terms of one- body transport models in which the system at any time is characterized by its single-particle density rather than by the full many-body information. In these one-body models evaluation of the single-particle density is determined by a transport equation which

contains the self-consistent mean-field potential and a collision term due to binary two-body collisions. Recently, this approach in a semi-classical limit with a Boltzmann-Uehling-Uhlenbeck (BUU) form of a collision term has been applied to nuclear collisions at intermediate energies. Common to all one-body models, only the average effects of two-body collisions are retained in the equation of motion and higher order correlations are entirely neglected. This approximation corresponds to an ensemble averaging which is evident, for example, from the "molecular chaos assumption" introduced in derivation of Boltzmann equation. As a result, these one-body models determine the ensemble averaged single-particle density and cannot provide a description for the fluctuation processes in nuclear collisions. On the other hand, at low and intermediate energies dynamical fluctuations are substantial due to large available phase space for decay into many final states. Therefore, it is of great interest to improve one-body transport models by incorporating dynamical fluctuations due to high order correlations into the equation of motion. 5 refs., 3 figs.

27200 (DOE/ER/40530–1) **Studies of fluctuation processes in nuclear collisions: Progress report, August 15, 1989–April 15, 1990.** Ayik, S. Tennessee Technological Univ., Cookeville, TN (USA). Dept. of Physics. Apr 1990. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-89ER40530. Order Number DE90009313. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report summarizes the progress on grant No. FG05–89ER40530 during the period August 15, 1989 to April 15, 1990. Most of the activity during this period was foucsed on providing a detailed description of a one-body transport model (stochastic BUU), and developing a method for obtaining approximate numerical solutions of the equation of motion. The stochastic BUU model goes beyond the standard BUU by incorporating dynamical fluctuations into the equation of motion. Therefore, it opens up a possibility for a dynamical description of multifragmentation processes in nuclear collisions at intermediate energies. Results of the first numerical calculations for head-on collisions of $^{12}C + ^{12}C$ and $^{40}Ca + ^{40}Ca$ systems at various energies are included in this report. The preliminary calculations have already revealed the substantial effects of fluctuations on the production mechanism of the intermediate mass fragments, and on the rare particle production mechanism in nuclear collisions. Work has also continued on establishing the connection between the one-body transport model and the collective transport models familiar from previous studies.

27201 (FRCEA-TH–90) **Study of the central interactions in the heavy ions induced reactions, at intermediate energies, by means of the fission fragments angular correlation method.** Mostefai, H. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Nucleaire a Basse Energie; Paris-11 Univ., 91 - Orsay (France). 1987. 108p. (In French). Order Number DE90770193. Available from NTIS (US Sales Only), PC A06/MF A01.

Heavy ion collisions are studied in the Fermi energy domain by means of the angular correlation method which allows to determine the amount of transferred linear momentum. Fragment mass measurements permit to deduce the excitation energies reached in the residual nuclei. The present results deal with reactions, induced on a thorium target by an argon beam from 31 to 44 MeV per nucleon and by a nickel beam from 20 to 30 MeV per nucleon. With the thorium target, the angular correlations show two components, one due to the sequential fission of the target, the other due to the central collisions, the contribution of which decreases with the incident energy. The transferred linear momentum for these central collisions does not correspond to the full transfer but shows a limitation well reproduced by a simple model taking into account the nucleon-nucleon interaction and by a preequilibrium emission model. This last calculation predicts also the excitation energies and the mass of the composite systems in agreement with the mass measurements. The shapes of the angular correlations and their evolution with bombarding energy are qualitatively explained through an abrasion-ablation model. One suggests an explanation of the high transfers in terms of two mechanisms: one due to peripheral collisions stable with the incident energy, the other one arising from central collisions for which the larger compression would lower the critical temperature and so decrease the cross section.

27202 (LBL–28295) **Aspects of incompressibility.** Myers, W.D. Lawrence Berkeley Lab., CA (USA). Dec 1989. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900181–1: 18. international workshop of the gross properties of nuclei and nuclear excitations, Hirschegg (Austria), 15-20 Jan 1990). Order Number DE90009215. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The nuclear matter incompressibility K_{∞} (usually called the "compressibility" for some reason lost in antiquity) has been receiving an increasing amount of attention lately. Quite a spirited discussion is underway between groups who favor rather low values for use in simulations of supernova explosions, those who favor much higher values for the explanation of certain measurements in high-energy nuclear collisions, and many others who favor various intermediate values. The purpose of this paper is to present some preliminary results concerning the value of K_{∞} arising from a statistical model of macroscopic nuclear properties that is currently under development by Wladek Swiatecki and myself. This model, which is described in the next section, is meant to serve as a replacement for the traditional Liquid Drop Model and Droplet Model and their various extensions. It is itself an extension of the Thomas-Fermi approach of Seyler and Blanchard. However, it is important to note that we do not regard this approach as a poor approximation to Hartree-Fock, but rather as a vast improvement over the traditional LDM type approaches with their obvious limitations for light nuclei, at the drip lines, for large deformations, and other extreme situations such as large amounts of angular momentum or electric charge. 11 refs., 4 figs.

27203 (LBL–28579) **The surface energy and the compressibility.** Myers, W.D. Lawrence Berkeley Lab., CA (USA). Feb 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900295–1: 6. workshop on nuclear dynamics, Jackson Hole, WY (USA), 17-24 Feb 1990). Order Number DE90009209. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the relationship between surface energy and compressibility as they relate to the nucleus. 5 refs., 4 figs. (LSP)

27204 (UCRL-ID–103170) **The Livermore electron elastic scattering data base.** Perkins, S.T.; Cullen, D.E. Lawrence Livermore National Lab., CA (USA). Mar 1990. 39p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010203. Available from NTIS, PC A03/MF A01; GPO Dep.

Electrons elastically scatter off of the atomic nucleus. Because of the large mass difference between an incident electron and a target nucleus, the electron loses negligible kinetic energy per collision but undergoes an angular deflection. In this paper, the Livermore electron elastic scattering data base is described. In the following section, the theory to obtain the cross sections is detailed. The ENDL data format is next discussed, along with the extensions that had to be made to it because of the large forward bias in the differential cross section. Finally, the manipulation to the results to obtain numerical consistency is shown. The analysis has yielded electron elastic scattering data for Z = 1 to 100 with energies from 10 to 100 Gev.

27205 (WHC-EP–0282) **REAC*2: Users manual and code description.** Mann, F.M. Westinghouse Hanford Co., Richland, WA (USA). Dec 1989. 120p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-87RL10930. Order Number DE90008126. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The computer code system REAC•2 calculates the transmutation of materials in a nuclear environment and produces tables of activities and related quantities. This easy-to-use system contains computer codes and libraries containing cross-section data, decay data, material compositions, and fluxes for various fusion devices and test facilities. This document describes the basis of the code, the organization, and the use of the code.

6540 Radiation and Shielding Physics

Refer also to citation(s) 25569, 25908, 26230, 26556

27206 (CONF-8908219–1) **2 + 1 dimensional quantum gravity and the braid group.** Carlip, S. Institute for Advanced Study, Princeton, NJ (USA). Oct 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER02220. (IASSNS-HEP–89/51). From Workshop on physics, braids and links; Banff (Canada); Aug 1989. Order Number DE90009036. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the following on quantum gravity: 2 + 1 gravity as a Chern-Simons theory; quantization; dynamics; the Braid group; and the emergence of space and time. 16 refs., 3 figs. (LSP)

27207 (KAERI/RR–750/88) **Nuclear data evaluation and group constant generation for reactor analysis.** Kim, Jung Do (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Lee, Jong Tae; Gil, Choong Sup. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 160p. (In Korean). Order Number DE90622617. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

A new 69-group nuclear data library for WIMS-KAERI code was generated using the ENDF/B-V, IV, JENDL-2, and ENDL-84 data and NJOY which is nuclear data processing code. Thermal reactor benchmark problems recommended by the Cross Section Evaluation Working Group at BNL were analyzed using this new library and WIMS-KAERI code. Using 14 benchmark problems the calculated average value and standard deviation for effective multiplication factors were 1.00303 and 0.00514, respectvely.(Author).

6550 Medical Physics

Refer also to citation(s) 26363

27208 (ENEA-RT-SAG–89-02) **The Italian radioprotection laws: Present state and future developments.** Cucchi, G. Bologna Univ. (Italy). Oct 1989. 36p. (In Italian). (RT/SAG–89-2). Order Number DE90764345. Available from NTIS (US Sales Only), PC A03.

The author reviews the organization of radioprotection for exposed workers and the population according to the Italian laws - especially DPR 185/64 - and to the Euratom directives 80/836 and 84/467 - these not yet in use in Italy - with particular consideration given to the new law on health reform. After considering the new radioactive measurement units, the author examines the duties of the sanitary technologists in medical radiology for radioprotection of exposed workers and population. He then examines the values of the maximum permissible radiation doses by comparing the Italian values with the Euratom ones. He also reviews the radiation danger signals and the role of the radiological technologist in protecting patiens from radioactive damage in conformity with Italian guidelines and the Euratom directive 84/466.

27209 (KAERI/MR–150/88) **Radiological safety and control.** Ha, Chung Woo (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Seo, Kyung Won; Chang, Si Young; Lee, Tae Young; Yoon, Yo Chang; Kim, Jang Lyul; Kim, Kyo Yoon; Chung, Bong Hwan; Chung, Kyung Ki; Lee, Ki Chang. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 137p. (In Korean). Order Number DE90623085. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The radiological safety control program in KAERI has been carried out to achieve an optimum radiation protection to radiation workers and visitors as well as to the general public around the nuclear facilities through the justification and the optimization of radiation protection based on the 'As Low As Reasonably Achievable(ALARA)' concept. This program consists of radiation area monitoring, personnel radiation exposure control, calibration of radiation monitoring instruments, and technical support for radiological safety and control. As the results of radiological safety control performances in 1988, it is pronounced that: a.The annual average external radiation level in the working areas shows the distribution, ranging from 0.02 to 22.53mR/hr in Daeduk Head Office and from 0.03 to 1.23mR/hr in Seoul Office. It appears to be of little differences compared with those of last years. b.No individual was exposed in excess of the annual dose limits set in the relevant regulation of the Atomic Energy Act. Their annual average personnel exposure appears to be 0.35mSv in Daeduk Head Office and 2.8mSv in Soul Office, which shows 20% decrease in Daeduk, and 35% decrease in Seoul compared with those of previous year. c. The calibration, maintenance and repair of radiation monitoring instruments which are commonly used in nuclear power plants and radioisotope application industries are very important in performing the radiological safety control and maintaining the tracerbility against the national standard. In 1988, as many as 4,458 calibrations including 282 calibration of KAERI owned instruments have been made available by the program. d. The technical support for radiological safety control was performed through the design consultation for decay tank manufacture of the Korea Cancer Center Hospital and the support for radiation monitoring activities in Seoul Office. (Author).

6560 Condensed Matter Physics

Refer also to citation(s) 26058, 26089, 26104, 26218, 26226, 26229, 26230, 26290, 26292, 26293, 26294, 26295, 26296, 26449, 26501, 26523, 26530, 27022, 27038, 27204, 27228

27210 (CEA-CONF–9440) **Exact critical properties of two-dimensional polymer networks from conformal invariance.** Duplantier, B. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique. Mar 1988. 16p. (CONF-8803125–: Universalities in condensed matter physics workshop, Les Houches (France), 15-24 Mar 1988). Order Number DE90770198. Available from NTIS (US Sales Only), PC A03/MF A01.

An infinity of exact critical exponents for two-dimensional self-avoiding walks can be derived from conformal invariance and Coulomb gas techniques applied to the O(n) model and to the Potts model. They apply to polymer networks of any topology, for which a general scaling theory is given, valid in any dimension d. The infinite set of exponents has also been calculated to $O(\epsilon^2)$, for $d=4-\epsilon$. The 2D study also includes other universality classes like the dense polymers, the Hamiltonian walks, the polymers at their θ-point. Exact correlation functions can be further given for Hamiltonian walks, and exact winding angle probability distributions for the self-avoiding walks.

27211 (CONF-900276–Absts.) **US-Japan workshop on atomic collisions in solids: Abstracts of lectures.** Oak Ridge National Lab., TN (USA). Mar 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From US/Japan workshop on atomic collisions in solids; Honolulu, HI (USA); 2-9 Feb 1990. Order Number DE90008979. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report contains abstracts on the following topics: techniques of scanning probe microscopy; new types of radiation; a search for wake-riding electrons using slow antiproton beams; antiproton wake: theory; bending of swift ion beams by graphite foils; angular momentum distribution of autoionizing rydberg states: produced by 64 MeV S ions in collisions with C foils; multiphonon energy exchange in atom-surface collisions; plans for positron experiments; resonant coherent excitation: experiment; line shapes in resonant coherent excitation: theory; MUSE experiments and Monte Carlo simulation; inelastic interactions of electrons and positrons with solids; density fluctuation detection; cluster-impact fusion; a model for cluster-impact fusion; thoughts on cold fusion; and plasmon decay.

27212 (DOE/ER/45076–T1) **[Inelastic electron scattering from surfaces]: Annual technical progress report.** Tong, S.Y. Wisconsin Univ., Milwaukee, WI (USA). 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER45076. Order Number DE90009365. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses research being done on inelastic electron scattering by surface phonons and proposed experiments in this area. (LSP)

27213 (ENEA-RT-TIB–89-19) **Evidence of emission of neutrons from a titanium-deuterium system.** De Ninno, A.; Lollobattista, G.; Martinis, L.; Mori, L.; Scaramuzzi, F.; Frattolillo, A.; Martone, M.; Podda, S. ENEA, Frascati (Italy). Centro Ricerche Energia. Jul 1989. 9p. (RT/TIB–89-19). Order Number DE90764333. Available from NTIS (US Sales Only), PC A02/MF A01.

Submitted to Europhysics Letters.

About 100 grams of titanium, in the shape of shavings, was placed in a stainless steel cell, which was tested for vacuum and high pressure both at room temperature and liquid nitrogen temperature. The cell was connected to a deuterium cylinder through valves and a pressure regulator. A special dewar could be placed around the cell, in order to change the cell temperature between room temperature and liquid nitrogen temperature. A BF3 neutron counter with high sensitivity was positioned quite close to the cell. The deuterium was kept in contact with the titanium bed at different temperatures and pressures for roughly one day and counts only just above the background had been detected. In order to examine the behaviour of the system in the desorption phase, the deuterium was evacuated from the system by vacuum pumping and the liquid nitrogen dewar was also removed, allowing the cell and its content to rise towards room temperature. After about 3 hours, neutrons began to show up with a kind of gaussian distribution in time. Evidence that the interaction of deuterium gas with titanium produced a flow of neutrons, seems to show that it is not necessary to use electrolysis in order to obtain a low temperature fusion reaction between deuterium nuclei. The experiment confirms that non-equilibrium conditions are necessary in order to produce such a phenomenon.

27214 (IC–89/294) **Theory of resonant donor-impurity magnetopolaron in semiconductor quantum wells.** Osorio, F.A.P. (Goias Univ., Goiania, GO (Brazil). Inst. de Matematica e Fisica); Maialle, M.Z.; Hipolito, O. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 12p. Order Number DE90622339. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We report for the first time a theoretical calculation for the resonant donor impurity magnetopolaron in GaAs-$GA_{1-x}Al_xAs$ quantum-well structures. The intra donor 1s → 2p, transition frequencies are calculated as a function of the magnetic field, by taking into account the polaron effects and nonparabolicity of the conduction band. We found a pinning behaviour due to interaction with LO phonons as suggested by the experimentalists. Our results for the peak positions of those transitions are in very good agreement with recent experimental data. (author). 18 refs, 1 fig.

27215 (IC–89/351) **Resistance due to a pseudorandom potential with slowly varying period.** Thakur, P.K.; Kumar, N. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 15p. Order Number DE90622340. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Complementing recent studies of wavefunction localisation due to the pseudorandom potential $V(n,\gamma,Q)=(V_0)\cos(2\pi n^\gamma Q)$, we have calculated directly the observable resistance $\rho(l)$ of the chain as function of its length (l) in the two physically distinct regimes $0<\gamma<1$ and $1<\gamma<2$. For $0<\gamma<1$ and sufficiently away from the band centre our numerical results show an overall exponential growth of resistance, with remarkably regular steps and plateaus having finestructure. This is readily understood as due to the local wave evanescence. For $\gamma>1$, however, the above behaviour persists for all energies except near the band centre. This is attributed to the local Bragg reflection. An approximate treatment based on invariant imbedding equations for the reflection amplitude gives qualitatively similar results, but predicts a faster than exponential growth, $\ln\rho(l)\approx l^{(3-\gamma)}$ for $1<\gamma<2$. (author). 9 refs, 3 figs.

27216 (IC–89/366) **Quantum Ising model on hierarchical structures.** Lin Zhifang; Tao Ruibao. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 11p. Order Number DE90622341. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A quantum Ising chain with both the exchange couplings and the transverse fields arranged in a hierarchical way is considered. Exact analytical results for the critical line and energy gap are obtained. It is shown that when R_1 not= R_2, where R_1 and R_2 are the hierarchical parameters for the exchange couplings and the transverse fields, respectively, the system undergoes a phase transition in a different universality class from the pure quantum Ising chain with $R_1=R_2=1$. On the other hand, when $R_1=R_2=R$, there exists a critical value R_c dependent on the furcating number of the hierarchy. In case of $R > R_c$, the system is shown to exhibit as Ising-like critical point with the critical behaviour the same as in the pure case, while for $R < R_c$ the system belongs to another universality class. (author). 19 refs, 2 figs.

27217 (IC–89/377) **Pulsed laser cleaning of antimony single crystal <111> surface.** Brezini, A. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 10p. Order Number DE90622381. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The <111> face of an antimony single crystal was irradiated under ultra-high-vacuum conditions by the 193 nm radiation of a high-power excimer laser. The effects of the laser beam on the sample as a function of the light Energy Density (ED) and of the annealing Repetition Number are presented. Surface studies by Auger electron spectroscopy scanning electron microscopy and low energy electron diffraction show that an atomically clean and well ordered surface can be produced by this method. A strong chemical reduction is induced by pulsed laser annealing above 100 to 130 mJ/cm^2. Surface analysis shows that, for an ED less than 500 mJ/cm^2, the surface evaporates without melting deeper than 200 nm. Evidences for oxide modification and for organic molecule description were observed even after irradiations with an ED as low as 45 mJ/cm^2. The surface reduction is described by a thermal model involving surface heating and subsequent evaporation of the oxide layer. The description and diffusion processes may involve both thermal and photolytic mechanisms. (author). 9 refs, 4 figs, 1 tab.

27218 (IC–89/413) **General nonlinear theory of quasiparticle dynamics and kinetics in crystals.** Pushkarov, D.I. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 45p. Order Number DE90622342. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In solid state physics quasiparticles are elementary excitations the excited states consist of. They are carriers of a corresponding type of motion of the whole system. There are different types of motion in every solid and the excitation of each type generates its own quasiparticles. It is seen therefore, that quantum mechanics, and, particularly, the quasiparticle approach, suggest a new way for characterizing systems whose dependence is not on their building elements but on the possible types of motion. In such a way the quantum mechanical consideration replaces the red particles and the periodic lattice potential by quasiparticles with complicated diversion law and consequently, one has to develop for quasiparticles new mechanics, new scattering theory, new statistics, new kinetics, etc. 17 refs.

27219 (KU-HCOE-FL2-R–89-19) **Depth distribution of martensite in xenon implanted stainless steels.** Johansen, A. (Copenhagen Univ. (Denmark). Fysisk Lab.); Johnson, E.; Sarholt-Kristensen, L.; Steenstrup, S.; Gerritsen, E.; Denissen, C.J.M.; Keetels, H.; Politiek, J.; Hayashi, N.; Sakamoto, I. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1989. 26p. (CONF-890943–: 1. European conference on accelerators in applied research and technology (ECAART-1), Frankfurt am Main (Germany, F.R.), 5-9 Sep 1989). Order Number DE90622349. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The amount of stress-induced martensite and its distribution in depth in xenon implanted austenitic stainless steel poly- and single crystals have been measured by Rutherford backscattering and channeling analysis, depth selective conversion electron Moessbauer spectroscopy, cross-sectional transmission electron microscopy and x-ray diffraction analysis. In low nickel 17/7, 304 and 316 commercial stainless steels and in 17:13 single crystals the martensitic transformation starts at the surface and develops towards greater depth with increasing xenon fluence. The implanted layer is nearly completely transformed, and the interface between martensite and austenite is rather sharp and well defined. In high nickel 310 commercial stainless steel and 15:19 and 20:19 single crystals, on the other hand, only insignificant amounts of martensite are observed. (orig.).

27220 (LA-UR-90-768) **Cloud hole-boring with long pulse CO_2 lasers.** Quigley, G.P.; Webster, R.B.; York, G.W. Los Alamos National Lab., NM (USA). [1990]. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900140-18: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 15-19 Jan 1990). Order Number DE90008946. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Chemically generated CO_2 laser pulses at 10.6 μm have been used to clear a 5 cm diameter hole through a stratus-like cloud in a laboratory cloud chamber. The results show that 100% clearing can be achieved. The mechanism is shown to be droplet shattering followed by evaporation. Under the conditions of the experiment, the channel closure is dominated by turbulent mixing and not droplet recondensation. 14 refs., 9 figs.

27221 (LBL-27503) **Simulated image maps for use in experimental high-resolution electron microscopy.** O'Keefe, M.A.; Dahmen, U.; Hetherington, C.J.D. Lawrence Berkeley Lab., CA (USA). Dec 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-891119-114: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90009176. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A "map" of all possible high-resolution images may be simulated for a crystalline specimen in a chosen orientation for any particular transmission electron microscope (HRTEM). These maps are useful during experimental high-resolution electron microscopy and make it possible to locate optimum imaging conditions even for foil thicknesses beyond the weak-phase object limit. Although defects such as grain boundaries are not generally periodic, image maps of perfect crystal can be used to optimize defect contrast during operation of the microscope by reference to the image of the perfect crystal neighboring the defect. 9 refs., 6 figs.

27222 (OUP-89-26) **A FORTRAN program for an IBM PC compatible computer for calculating kinematical electron diffraction patterns: CRYSTAL.EXE Ver 2.0.** Skjerpe, P. Oslo Univ. (Norway). Fysisk Inst. 1989. 52p. Order Number DE90622350. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This report describes a computer program which is useful in transmission electron microscopy. The program is written in FORTRAN and calculates kinematical electron diffraction patterns in any zone axis from a given crystal structure. Quite large unit cells, containing up to 2250 atoms, can be handled by the program. The program runs on both the Helcules graphic card and the standard IBM CGA card.

27223 (RISO-M-2731) **Magnetic fluctuations in heavy fermion systems: A neutron scattering study of UPtsub 3, Usub 2Znsub 17 and URusub 2Sisub 2.** Broholm, C.L. Risoe National Lab., Roskilde (Denmark). Jun 1989. 78p. Order Number DE90622351. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Magnetic order and fluctuations in the heavy Fermion systems UPt_3, U_2Zn_{17} and URu_2Si_2 have been studied by neutron scattering. Single crystalline samples and triple-axis neutron-scattering techniques with energy transfers between 0 and 40 meV and energy resolutions between 0.1 meV and 4 meV have been employed. UPt_3 develops an antiferromagnetically ordered moment of (0.02 ± 0.005) μ_B below T_N = 5 K which doubles the unit cell in the basal plane and coexists with superconductivity below T_c = 0.5 K. The magnetic fluctuations are relaxational, and enhanced at the antiferromagnetic zone center in a low-energy regime. The characteristic zone-center relaxation energy is 0.3 meV. The temperature- and field-dependence of the antiferromagnetic order in the superconducting phase suggest a close relation between these two properties in UPt_3. U_2Zn_{17} has a broad spectrum of magnetic fluctuations, even below T_N = 9.7 K, of which the transverse part below 10 meV is strongly enhanced at the antiferromagnetic zone center. The system has an anomalously extended critical region and the antiferromagnetic phase transition seems to be driven by the temperature-dependence of an effective RKKY interaction, as anticipated theoretically. URu_2Si_2, a strongly anisotropic heavy Fermion system, has a high-energy regime of antiferromagnetically-correlated overdamped magnetic fluctuations. Below T_N = 17.5 K weak antiferromagnetic order, μ = $(0.04\pm0.01)\mu_B$, with finite correlations along the tetragonal c axis, develops along with a low-energy regime of strongly dispersive singlet-singlet excitations. Below T_c = 1 K antiferromagnetism coexists with superconductivity. A phenomenological model describing the exchange-enhanced overdamped magnetic fluctuations of heavy Fermion systems is proposed. (Abstract Truncated)

27224 (UCRL-CR-103295) **High-resolution Brillouin gain spectroscopy in solids.** Faris, G.W. (SRI International, Menlo Park, CA (USA). Molecular Physics Lab.); Jusinski, L.E.; Dyer, M.J.; Bischel, W.K.; Hickman, A.P. Lawrence Livermore National Lab., CA (USA); SRI International, Menlo Park, CA (USA). Molecular Physics Lab. 18 Dec 1989. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009475. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We report the first high-resolution Brillouin gain spectroscopy in solids to our knowledge. Resonances corresponding to longitudinal (compressional) and transverse (shear) acoustic waves in fused silica are observed with good resolution and high signal to noise. Absolute gain coefficients, linewidths, and Brillouin frequency shifts are measured. Agreement with previously measured values is good. 15 refs., 3 figs., 1 tab.

27225 **Theory of semiconductor superlattice electronic structure.** Smith, D.L. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Mailhiot, C. *Reviews of Modern Physics (USA)*, 62(1): 173-234 (Jan 1990).

The authors review the theory of semiconductor superlattice electronic structure. First a survey of theoretical methods is presented. These methods can be divided into two general classes: the supercell approach in which the superlattice is viewed as a material with a large unit cell, and the boundary-condition approach in which bulk wave functions in the constituent semiconductors are matched at the superlattice interfaces. Supercell approaches are essentially the same as conventional band-structure methods. They can only be applied to thin-layer superlattices because of numerical cost. The authors discuss problems of interface matching that occur in various boundary-condition methods and relate these methods to each other. A particular boundary-condition method is used to discuss the electronic structure of various III-V semiconductor superlattices. Emphasis is placed on discussing the qualitatively different behavior that can arise because of different energy-band lineups, strain conditions, and growth orientations. The authors compare the results of three commonly used boundary-condition methods and find generally good agreement.

6561 Superconductivity

Refer also to citation(s) 26095, 25126, 26129, 26148, 26277, 26474

27226 (AD-A-216393/9/XAB) **BCS (Bardeen-Cooper-Schrieffer) primer: A guide to computational methods in superconductivity theory.** Sahu, D.; Langner, A.; George, T.F. State Univ. of New York, Buffalo, NY (USA). Dept. of Chemistry. Dec 1989. 11p. (UBUFFALO/DC-89/TR-4). Available from NTIS, PC A03/MF A01.

Because of the recent revival of interest in superconductivity, we have felt that a pedagogical, yet concise review of the fundamental ideas of the Bardeen-Cooper-Schrieffer (BCS) theory of superconductivity is timely. We discuss the basic ideas of the BCS theory and list the formulae for the thermodynamic quantities of this theory in the usual real-time representation. We also represent these formulae in the alternate imaginary-time representation, which makes hands-on numerical evaluation of the thermodynamic quantities of interest readily accessible. Finally, we pointout the limitations of the BCS theory and describe some of its proposed extensions for describing the behavior of some of the new, unconventional superconductors.

27227 (KU-HCOE-FL2-R-89-20) **Theory of the magnetic excitations in the Cu-O superconductors.** Hedegard, P. (Copenhagen Univ. (Denmark). Fysisk Lab.); Brix Pedersen, M. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 26 Nov 1989.

13p. Order Number DE90622532. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We show that all the features of the recent neutron scattering data by Shirane et al. on large, superconducting single crystals can be explained in a model with singlet pairing of bosonic spins. The temperature dependence of the integrated intensity seen experimentally is due to the creation of two spin excitations out of the pair condensate in one scattering event. The Goldstone modes of the theory are identified, and suggestions for experimental tests are given. (orig.).

6570 Theoretical and Mathematical Physics

Refer also to citation(s) 26254, 27056, 27084, 27206

27228 (IC–89/226) **Finite cluster renormalization and new two step renormalization group for Ising model.** Benyoussef, A. (Faculte des Sciences, Rabat (Morocco). Lab. de Magnetisme); El Kenz, A. International Centre for Theoretical Physics, Trieste (Italy). Sep 1989. 13p. Order Number DE90622166. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

New types of renormalization group theory using the generalized Callen identities are exploited in the study of the Ising model. Another type of two-step renormalization is proposed. Critical couplings and critical exponents y_T and y_H are calculated by these methods for square and simple cubic lattices, using different size clusters. (author). 17 refs, 2 tabs.

27229 (IC–89/255) **On multivalued nonexpansive type maps.** Latif, A. International Centre for Theoretical Physics, Trieste (Italy). Aug 1989. 7p. Order Number DE90622167. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Some elementary properties of multivalued nonexpansive type maps are derived and used to obtain fixed point results for such maps. (author). 10 refs.

27230 (IC–89/274) **Some varieties of the K-Kolmogorov homology groups.** Abd El-Sattar, A. Dabbour. International Centre for Theoretical Physics, Trieste (Italy). Sep 1989. 9p. Order Number DE90622168. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The aim of the present article is to give two descriptions of the K-Kolmogorov homology groups given, and also their relations to other groups. (author). 12 refs.

27231 (IC–89/334) **On the transformation of invariance and the exact solutions of the Rabi model.** Rustamov, K.A. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 7p. Order Number DE90622181. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The transformations of invariance of the Rabi model describing the interaction of the two-level system with the I-mode electromagnetic field are constructed. On this basis the explicit expressions for the coherent states and the Green function of the problem are obtained. (author). 15 refs.

27232 (IC–89/336) **New formulation of quantum mechanics.** Roncadelli, M. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 15p. Order Number DE90622182. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

As the path integral approach explicitly shows, nonrelativistic quantum dynamics can be viewed as a stochastic diffusion process defined by a probability amplitude over the sample trajectories. We offer a new formulation of quantum mechanics where these paths are understood as solutions of a Langevin equation with a Fresnel noise (white noise with imaginary two-point function). Physically, the associated functional (pseudo) measure is interpreted as the probability amplitude for a single noise configuration. We obtain in this way the propagator of the Schroedinger equation as an average over the Fresnel noise involving the above solutions. Our approach is explicitly based on classical dynamics, since the drift in the Langevin equation is controlled by Hamilton's principal function. We are thus able to explicitly show that quantum mechanics is actually classical dynamics in the presence of the fluctuations described by the Fresnel noise (they have a purely kinematical and universal nature). As a result, a clear-cut answer emerges to the question: What should be added to classical mechanics to get quantum mechanics? We also show that the path integral approach becomes a straightforward consequence of the present formulation. We conclude by pointing out various implications of the strategy discussed in this Letter. (author). 18 refs.

27233 (IC–89/339) **Radiating spheres in general relativity with a mixed transport energy flow.** Barreto, W.; Nunez, L.A. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 27p. Order Number DE90622194. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A seminumeric method by Herrera, Jimenez and Ruggeri is extended to handle the evolution of general relativistic spheres where diffusion and free streaming radiation processes coexist. It is shown when mixed-mode radiation is present a very different hydrodynamic picture emerges from the models previously considered in both radiation limits. Characteristic times for free streaming, hydrodynamics and diffusion processes are considered comparable. Hydrodynamics and radiation are strongly coupled and the particular equation of state of the model emerges as a very important element in the dynamic of the matter distribution. (author). 16 refs, 5 figs.

27234 (IC–89/340) **Luminosity profiles and the evolution of shock waves in general relativistic radiating spheres.** Herrera, L. (Universidad Central de Venezuela, Caracas (Venezuela). Dept. de Fisica); Nunez, L.A. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 37p. Order Number DE90622195. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A method recently proposed by the authors to study the evolution of discontinuities in radiating spherically symmetric distributions of matter is systematically applied to model the evolution of a composite radiant sphere. The matter configuration, free of singularities, is divided in two regions by a shock wave front, and at each side of this interface a different equation of state is considered. Solutions are matched across the shock via the Rankine-Hugoniot conditions while the outer region metric joins the Vaidya solution at the boundary surface. The influence on the evolution of these composite spheres of different shapes of neutrino outburst profiles, and particular neutrino-transfer processes from the inner core to the outer mantel is explored. Prospective applications to supernova scenarios are discussed. (author). 18 refs, 4 figs, 1 tab.

27235 (IC–89/341) **Talking from d'Alembert formula.** Liu Ruxun. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 12p. Order Number DE90622169. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In the paper, two new approaches to prove the famous d'Alembert formula are proposed, and some further extensions of the formula also advanced. Many interesting results and application prospects are discussed. (author). 2 refs, 3 figs.

27236 (IC–89/343) **Using the mean approach in pooling cross-section and time series data for regression modelling.** Nuamah, N.N.N.N. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 13p. Order Number DE90622170. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The mean approach is one of the methods for pooling cross section and time series data for mathematical-statistical modelling. Though a simple approach, its results are sometimes paradoxical in nature. However, researchers still continue using it for its simplicity. Here, the paper investigates the nature and source of such unwanted phenomena. (author). 7 refs.

27237 (IC–89/345) **On a class of graphs with prescribed mean curvature.** Duong Minh Duc (International Centre for Theoretical Physics, Trieste (Italy)); Costa Salavessa, I.M. de. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 26p. Order Number DE90622171. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We study a class of quasilinear elliptic equations on the unit ball of R^n and apply these results to get the existence of graphs with prescribed mean curvature on n-hyperbolic spaces. (author). 18 refs.

27238 (IC–89/349) **On a non-linear pseudodifferential boundary value problem.** Nguyen Minh Chuong. International

Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 7p. Order Number DE90622172. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A pseudodifferential boundary value problem for operators with symbols taking values in Sobolev spaces and with non-linear right-hand side was studied. Existence and uniqueness theorems were proved. (author). 11 refs.

27239 (IC–89/352) **On orders solely of Abelian groups III.** Srinivasan, S. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 7p. Order Number DE90622173. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Here we make the unspecified constants, occurring in the asymptotic formulae for the counting functions of Abelian groups, explicit. (author). 5 refs.

27240 (IC–89/353) **Scaling of the first-passage time of biased diffusion on hierarchical comb structures.** Lin Zhifang; Tao Ruibao. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 11p. Order Number DE90622174. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Biased diffusion on hierarchical comb structures is studied within an exact renormalization group scheme. The scaling exponents of the moments of the first-passage time for random walks are obtained. It is found that the scaling properties of the diffusion depend only on the direction of bias. In this particular case, the presence of bias may give rise to a new multifractality. (author). 7 refs, 2 figs.

27241 (IC–89/364) **The classical relativistic two-body problem with spin and self-interactions.** Barut, A.O.; Onem, C.; Unal, N. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 19p. Order Number DE90622183. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The recent classical model of a spinning Dirac particle with Zitterbewegung is generalized to two particles interacting electromagnetically. A variational principle is formulated which leads to covariant Hamiltonian with separate centre of mass and relative terms much like the quantum 2-body Dirac equation. The relative motion has the same form as the spinless case but with the time dependent modulated coupling constant representing the spin effects. The canonical quantization of the theory is immediate. (author). 10 refs.

27242 (IC–89/367) **Path integral solution for some time-dependent potential.** Storchak, S.N. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 7p. Order Number DE90622184. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The quantum-mechanical problem with a time-dependent potential is solved by the path integral method. The solution is obtained by the application of the previously derived general formula for rheonomic homogeneous point transformation and reparametrization in the path integral. (author). 4 refs.

27243 (IC–89/373) **Kahlerian submanifolds of R^n.** Ferreira, M.J.; Tribuzy, R. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 15p. Order Number DE90622175. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We describe a class of isometric immersions with parallel-circular operator in terms of (1,1) geodesic maps. More specifically, we classify all isometric immersions, from a Kaehler manifold into the Euclidean space R^n, whose "complex Gaussmap" is (1,1) geodesic. This classification, in turn, provides examples of (1,1) = geodesic maps from a Kaehler manifold into a complex Grassmannian. 11 refs.

27244 (IC–89/383) **Quadratic isoparametric systems in R_p^{n+m}.** Kashani, S.M.B. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 20p. Order Number DE90622176. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The object of this paper is to introduce quadratic isoparametric systems in R_p^{n+m}, to classify such systems with codim 2 and to prove that the quadratic isoparametric submanifolds obtained from these systems are homogeneous. (author). 4 refs.

27245 (IC–89/385) **On inversion of the coefficients for hyperbolic PDE.** Liu Ruxun. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 14p. Order Number DE90622177. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this paper, the characteristic concept and the characteristic methods are developed to deal with the inversion of the coefficients for hyperbolic PDE. (author). 4 refs, 3 figs.

27246 (IC–89/393) **Sufficient conditions for oscillation and nonoscillation of solutions of a class of second order functional differential equations.** Parhi, N. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 10p. Order Number DE90622178. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In this paper, sufficient conditions have been obtained for nonoscillation of bounded solutions of forced second order functional differential equations involving the derivative with delay. Also sufficient conditions have been obtained for oscillation of all solutions of forced second order functional differential equations. (author). 7 refs.

27247 (JINR-E–4-88-739) **Dynamic two-center problem: triple-collision-limit solution.** Ishihara, T. (Tsukuba Univ., Ibaraki (Japan)); Fukuda, H.; Matveenko, A.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 12p. Order Number DE90622185. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We have derived analytic solutions of the dynamic two-center problem (adiabatic hyperspherical hamiltonian) in the vicinity of the tripple-collision point. They are rotated hyperspherical harmonics with quantum numbers of the total angular momentum, parity and pair Jacobi angular momentum. Their particular form is both general and simplest available. 24 refs.; 2 figs.

27248 (LA-UR–90-1026) **Do positrons and antiprotons respect the weak equivalence principle?.** Hughes, R.J. Los Alamos National Lab., NM (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-900183–1: Recontres De Moriond '90: new and exotic phenomena, Les Arcs (France), 20-27 Jan 1990). Order Number DE90008915. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We resolve the difficulties which Morrison identified with energy conservation and the gravitational red-shift when particles of antimatter, such as the positron and antiproton, do not respect the weak equivalence principle. 13 refs.

27249 (NBI-HE–89-59) **Baby universe theory.** Nielsen, H.B. (Niels Bohr Inst., Copenhagen (Denmark)); Ninomiya, Masao. Niels Bohr Inst., Copenhagen (Denmark). Dec 1989. 46p. (CONF-8902170–: 3. regional conference on mathematical physics, Islamabad (Pakistan), 18-24 Feb 1989). Order Number DE90622196. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We give an elementary review of the so called 'the theory of baby universes' which is a series of ideas or speculations about some effects in quantum gravity, viz. the effect of a certain type of wormholes, representing the exchange of small 3-space universes called baby universes. We consider this 'theory' as being physically and scientifically a very promising candidate for a theory of everything. It is, however, mathematically lacking any strong foundation at all. It solves several fine-tuning problems: First of all the cosmological constant problem, and also the strong CP-problem and the hierarchy problem. We also speculate that it might predict the possibility of influencing the probability distributions of the outcome of quantum mechanical measurements at one time by acts at a later time. (orig.).

27250 (SAND–90-0242C) **Is Galerkin's method really better?.** Peterson, A.F. (Georgia Inst. of Tech., Atlanta, GA (USA). School of Electrical Engineering); Jorgenson, R.E. Sandia National Labs., Albuquerque, NM (USA). [1990]. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9003128–1: 6. annual review of progress in applied computational electromagnetics, Monterey, CA (USA), 20-22 Mar 1990). Order Number DE90008804. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The selection of basis and testing functions within a method-of-moments discretization is an important issue in computational electromagnetics. There appears to be widespread belief that Galerkin's method (selecting the same functions for basis and testing) will generally produce better results than some other choice. To investigate this issue, a variety of discretizations have been studied for several canonical electromagnetics problems. Results suggest that the accuracy of the discretization depends primarily on the order or "smoothness" of the basis and testing functions, and that there is nothing particularly noteworthy about the accuracy obtained with Galerkin's method. 6 refs., 3 figs., 2 tabs.

27251 **Huygens–Fresnel–Kirchhoff wave-front diffraction formulation: paraxial and exact Gaussian laser beams.** Kraus, H.G. (Idaho National Engineering Laboratory, EG&G Idaho Incorporated, P.O. Box 1625, Idaho Falls, Idaho 83415 (US)). *Journal of the Optical Society of America, Part A: Optics and Image Science (USA)*, 7(1): 47-65 (Jan 1990). DOE Contract AC07-76ID01570.

The Huygens–Fresnel diffraction integral has been formulated for incident Gaussian laser beams by using the Kirchhoff obliquity factor with the wave front instead of the aperture plane as the surface of integration. Accurate numerical-integration calculations were used to investigate the Fresnel field diffraction region for the much-studied case of a circular aperture. It is shown that the classical aperture-plane formulation becomes inaccurate when the wave front, as truncated at the aperture, has any degree of curvature to it, whereas the newly developed wave-front formulation produces accurate results for as much as one aperture diameter behind the aperture plane. The wave-front diffraction integral was developed for both the classical paraxial and the recently developed exact solutions to the scalar wave equation for a Gaussian beam. Detailed comparisons of these two diffraction solutions show that they are essentially identical for the typical laboratory laser. The typical laboratory laser is defined as having a wavelength in the near-infrared-through-visible range, a beam diameter as large as several millimeters, and a beam divergence angle as large as several milliradians.

27252 **Flux-carrying fermions and the second virial coefficient.** Blum, T. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627 (USA)); Hagen, C.R.; Ramaswamy, S. *Physical Review Letters (USA)*, 64(7): 709-712 (12 Feb 1990).

The second virial coefficient B_2 for a system of spin-one-half flux-carrying fermions is computed. It is found that there arise significant differences from known results for the corresponding spinless system. Apart from the existence of cusps and a restricted periodicity of B_2 when viewed as a function of the flux parameter α, one obtains here the remarkable result that there exist discontinuities in B_2 at all even, nonzero values of α.

27253 **Free-energy functionals at the high-gradient limit.** Rosenau, P. (Department of Mechanical Engineering, Technion, Israel Institute of Technology, Haifa 32000, (Israel)— Center for Nonlinear Studies, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)). *Physical Review, A (General Physics) (USA)*, 41(4): 2227-2230 (15 Feb 1990). KC-07-01-01.

It is shown that free energy functionals have a unique infinite-gradient limit which assures a finite interaction energy. This limit is used to extrapolate the Ginzburg-Landau small-gradient theory. The resulting functionals allow the existence of cusped equilibria or equilibria with *sharp* interfaces. If perturbed, a sharp interface will not quench immediately, but rather dissolve within a finite time.

70 FUSION ENERGY

Refer also to citation(s) 27211, 27213

27254 (CONF-9003118–2) **The initiation of excess power and possible products of nuclear interactions during the electrolysis of heavy water.** Scott, C.D.; Mrochek, J.E.; Scott, T.C.; Michaels, G.E.; Newman, E.; Petek, M. Oak Ridge National Lab., TN (USA). [1990]. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 1. annual conference on cold fusion; Salt Lake City, UT (USA); 28-31 Mar 1990. Order Number DE90009228. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The electrolysis of heavy water is being investigated with an insulated flow calorimetric system. The electrolyte was 0.1 to 1.0 N LiOD in D_2O and cylindrical palladium cathodes surrounded by wire-wound platinum anodes have been used at cathode current densities of 100 to 800 mA/cm^2. The most recent test has been made with a "closed system" without off-gal in which the electrolysis gases were internally recombined. Fast neutrons and gamma rays were measured continuously during the tests. It was shown that certain system perturbations could initiate and extend generation of excess power. In one test, there was an apparent increase in the neutron count rate that was also coincident with system perturbations. 4 refs., 6 figs.

27255 (DOE/ET/53088–421) **Direct conversion of muon catalyzed fusion energy.** Tajima, T. (Texas Univ., Austin, TX (USA). Inst. for Fusion Studies); Eliezer, S.; Kulsrud, R.M. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Mar 1990. 33p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–421). Order Number DE90009338. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In this paper a method of direct conversion of muon catalyzed fusion (MCF) energy is proposed in order to reduce the cost of muon production. This MCF concept is based on a pellet composed of many thin solid deuterium-tritium (DT) rods encircled by a metallic circuit immersed in a magnetic field. The direct energy conversion is the result of the heating of the pellet by beam injection and fusion alphas. The expanding DT rods causes the change of magnetic flux linked by the circuit. Our calculation shows that the direct conversion method reduces the cost of one muon by a factor of approximately 2.5 over the previous methods. The present method is compatible with a reactor using the pellet concept, where the muon sticking is reduced by the ion cyclotron resonance heating and the confinement of the exploding pellet is handled by magnetic fields and the coronal plasma. 17 refs., 6 figs.

27256 (ENEA-RT-FUS–89-01) **Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13–17 Mar 1989).** ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. 85p. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

Individual papers are indexed separately.

27257 (ORNL–6528) **Fusion Energy Division annual progress report, period ending December 31, 1988.** Sheffield, J.; Berry, L.A.; Saltmarsh, M.J. Oak Ridge National Lab., TN (USA). Feb 1990. 259p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010224. Available from NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.

This report discusses the following topics on fusion research: toroidal confinement activities; atomic physics and plasma diagnostics development; fusion theory and computation; plasma technology; superconducting magnet development; advanced systems program; fusion materials research; neutron transport; and management services, quality assurance, and safety.

7001 Plasma Research

Refer also to citation(s) 27041, 27048, 27326, 27328

27258 (ANU-PRL-PP–88/3) **Experimental studies of a plasma confined in a toroidal heliac.** Blackwell, B.D.; Hamberger, S.M.; Sharp, L.E.; Shi, X.H. Australian National Univ., Canberra (Australia). Plasma Research Lab. [1988]. 33p. Order Number DE90622424. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The design, construction and operation of the prototype heliac SHEILA are described. Gas breakdown conditions are compared with high frequency discharges. Plasma isobars obtained from local measurements are shown to agree closely with computed magnetic flux surfaces for a range of magnetic configurations. The effect of

changing the configuration on fluctuation mode numbers is demonstrated and shown to be consistent with the calculated rotational transforms. 30 refs., 24 figs., 2 tabs.

27259 (ANU-PRL-PP–89/1) **Studies of drift waves in a toroidal heliac.** Shi, X.H.; Blackwell, B.D.; Hamberger, S.M. Australian National Univ., Canberra (Australia). Plasma Research Lab. [1989]. 44p. Order Number DE90622457. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Low frequency, coherent density fluctuations have been studied for three typical magnetic configurations in the helical axis stellarator SHEILA using Langmuir probe techniques. The parametric dependence, the thréshold magnetic field, the frequency spectrum and the spatial structure of the fluctuations are measured experimentally. Mode analyses are made in a magnetic coordinate system. Both the mode numbers thus obtained and the smallness of the directly measured values of the wavenumber along the magnetic field lines indicate a close correspondence between the helicity of the fluctuations and the field lines. These experimental results are consistent with a collisional drift wave model, derived from a linearized two-fluid theory, related to the heliac geometry. Density reduction associated with the fluctuations is clearly observed and is consistent with rough estimates of the cross-filed particle flux due to the fluctuations. 17 refs., 18 figs., 1 tab.

27260 (ANU-PRL-PP–89/7) **Diffraction tomography for plasma refractive index measurements.** Howard, J.; Nazikian, R.; Sharp, L.E. Australian National Univ., Canberra (Australia). Plasma Research Lab. 1989. 30p. Order Number DE90622446. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Measurement of the properties of probing beams of coherent electromagnetic radiation yields essential information about the line of sight integrated plasma refractive index. Presented is a scalar diffraction treatment of forward angle scattering plasma diagnostics based on the diffraction projection theorem first presented by E. Wolf in 1969. New results are obtained for near field scattering from probing Gaussian beams and it is demonstrated that the effects of diffraction need to be addressed for tomographic inversion of near field scattering and interferometry data. 33 refs., 10 figs.

27261 (CONF-9003128–2) **Full wave computation of electromagnetic wave excitation, propagation, and absorption at the ion cyclotron frequency in fusion experiments.** Batchelor, D.B.; Jaeger, E.F. Oak Ridge National Lab., TN (USA). [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 6. annual review of progress in applied computational electromagnetics; Monterey, CA (USA); 20-22 Mar 1990. Order Number DE90009399. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

High-power electromagnetic waves at frequencies ranging from a few megahertz to a few hundred gigahertz serve many important functions in modern fusion experiments. Probably the most important application is plasma heating. Ignition of a fusion reactor will require a plasma to be heated until the average particle energy is ~10 keV (temperature > 10^8 K). This is routinely accomplished in existing large devices. Waves at the ion cyclotron frequency (typically f = 30 to 100 MHz) are very important for fusion devices because of low cost/unit power compared to other frequency regimes and because of their ability to directly heat fusile ions. These waves are also useful for modifying the velocity distribution for improved stability and to drive currents which affect plasma equilibrium. Study of this frequency range is, however, greatly complicated by long wavelengths compared to device size, nonsymmetric device geometry, and the tendency of the waves to linearly transform to shorter wavelength modes. Geometrical optics is generally inapplicable. Thus, codes have been developed to solve the vector wave equation in toroidal geometry for hot plasmas having anisotropic, spatially nonuniform, dispersive constitutive relations. In this paper we describe the code ORION developed at Oak Ridge National Laboratory and present illustrative applications to a range of fusion experiments. Specific applications of the code include detailed modeling of the antennas used to launch the waves, calculation of wave propagation throughout the plasma, and modeling of the absorption of the waves by the plasma. 11 refs., 3 figs.

27262 (DOE/ET/53088–408) **MHD [magnetohydrodynamic] modes driven by anomalous electron viscosity and their role in fast sawtooth crashes.** Aydemir, A.Y. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. 13 Feb 1990. 27p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–408). Order Number DE90009311. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We derive the dispersion relations for both small and large-Δ' modes ($m \geq 2$, and $m = 1$ modes, respectively) driven by anomalous electron viscosity. Under the assumption that the anomalous kinematic electron viscosity is comparable to the anomalous electron thermal diffusivity, we find that the viscous mode typically has a higher growth rate than the corresponding resistive mode. We compare computational results in cylindrical and toroidal geometries with theory and present some nonlinear results for viscous m = 1 modes in both circular and D-shaped boundaries and discuss their possible rile in fast sawtooth crashes. 30 ref., 5 figs., 1 tab.

27263 (DOE/ET/53088–410) **Point vortex description of drift wave vortices: Dynamics and transport.** Kono, M. (Texas Univ., Austin, TX (USA). Inst. for Fusion Studies); Horton, W.; Matsuoka, C. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Dec 1989. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–410). Order Number DE90009339. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Point vortex description for drift wave vortices is formulated based on the Hasegawa-Mima equation to study elementary processes for the interactions of vortices as well as statistical properties like vortex diffusion. Dynamical properties of drift wave vortices known by numerical experiments are recovered. Furthermore a vortex diffusion model discussed by Horton based on numerical simulations is shown to be analytically obtained. A variety of phenomena arising from the short-range nature of the interaction force of point vortices are suggested. 9 refs., 6 figs.

27264 (DOE/ET/53088–414) **The effect of viscosity on the resistive tearing mode with the presence of shear flow.** Chen, X.L. (Texas Univ., Austin, TX (USA)); Morrison, P.J. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Jan 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–414). Order Number DE90009340. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The effect of small isotropic viscosity on the "constant ψ" tearing mode in the presence of shear flow, is analyzed by the boundary layer approach. It is found that the influence of viscosity depends upon the parameter $(G'(0)/F'(0))$, where $G'(0)$ and $F'(0)$ denote that shear and magnetic field shear at the magnetic null plane, respectively. When $|(G'(0)/F'(0))| \ll 1$, the tearing mode growth rate is suppressed by the viscosity, but not completely stabilized. When $|(G'(0)/F'(0))| \sim$ in the order of (1) and the viscosity is comparable with the resistivity, the growth rate vanishes as $((1 - G'(0)^2/F'(0)^2)^{1/3})$, when $G'(0)^2 \rightarrow F'(0)^2$ from below. In the case where $(1 - G'(0)^2/F'(0)^2) < 0$ matching cannot be achieved. 8 refs.

27265 (DOE/ET/53088–417) **Transition from resistive-g to eta-i driven turbulence in stellarator systems.** Hong, B.-G. (ENEA, Frascati (Italy). Centro Ricerche Energia); Horton, W.; Hamaguchi, S.; Wakantani, M.; Yagi, M.; Sugama, H. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Feb 1990. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–417). Order Number DE90009382. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

By an electromagnetic incompressible two fluid model describing both ion temperature gradient drift modes (η_i modes) and resistive interchange modes (g modes), a new type of η_i mode is studied in cylindrical geometry including magnetic shear and an averaged curvature of Heliotron/Torsatron. This η_i mode is destabilized by the coupling to the unstable g mode. Finite plasma pressure beta increases the growth rate of this mode and the radial mode width also increases with plasma pressure beta indicating large anomalous transport in the Heliotron/Torsatron configuration. The transport from η_i mode exceeds that from resistive g when the mean-free-path exceeds the machine circumference. For plasma beta above two to three times the Suydam limit the $m = 1/n = 1$ growth rate increases from the η_i mode value to the MHD value. 13 refs., 5 figs.

27266 (DOE/ET/53088–418) **Instabilities and vortex dynamics in shear flow of magnetized plasmas.** Tajima, T.; Horton, W.; Morrison, P.J.; Schutkeker, J.; Kamimura, T.; Mima, K.; Abe, Y. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Mar 1990. 64p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract FG05-80ET53088. (IFSR–418). Order Number DE90009448. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

Gradient-driven instabilities and the subsequent nonlinear evolution of generated vortices in sheared E × B flows are investigated for magnetized plasmas with and without gravity (magnetic curvature) and magnetic shear by using theory and implicit particle simulations. In the linear eigenmode analysis, the instabilities considered are the Kelvin-Helmholtz (K-H) instability and the resistive interchange instability. The presence of the shear flow can stabilize these instabilities. The dynamics of the K-H instability and the vortex dynamics can be uniformly described by the initial flow pattern with a vorticity localization parameter ϵ. The observed growth of the K-H modes is exponential in time for linearly unstable modes, secular for marginal mode, and absent until driven nonlinearly for linearly stable modes. The distance between two vortex centers experiences rapid merging while the angle θ between the axis of vortices and the external shear flow increases. These vortices proceed toward their overall coalescence, while shedding small-scale vortices and waves. The main features of vortex dynamics of the nonlinear coalescence and the tilt or the rotational instabilities of vortices are shown to be given by using a low dimension Hamiltonian representation for interacting vortex cores in the shear flow. 24 refs., 19 figs., 1 tab.

27267 (DOE/ET/53088–420) **The energy-momentum tensor for the linearized Maxwell-Vlasov and kinetic guiding center theories.** Pfirsch, D. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Morrison, P.J. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Feb 1990. 36p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–420). Order Number DE90009336. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A modified Hamilton-Jacobi formalism is introduced as a tool to obtain the energy-momentum and angular-momentum tensors for any king of nonlinear or linearized Maxwell-collisionless kinetic theories. The emphasis is on linearized theories, for which these tensors are derived for the first time. The kinetic theories treated — which need not be the same for all particle species in a plasma — are the Vlasov and kinetic guiding center theories. The Hamiltonian for the guiding center motion is taken in the form resulting from Dirac's constraint theory for non-standard Lagrangian systems. As an example of the Maxwell-kinetic guiding center theory, the second-order energy for a perturbed homogeneous magnetized plasma is calculated with initially vanishing field perturbations. The expression obtained is compared with the corresponding one of Maxwell-Vlasov theory. 11 refs.

27268 (DOE/ET/53088–423) **Stability of the gas dynamic trap.** Berk, H.L.; Stupakov, G.V. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Mar 1990. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–423). Order Number DE90009335. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The description of stability of the gas dynamic trap is shown to be extremely sensitive to the nature of the boundary conditions. Two model boundary conditions in a moderately long mean free path limit are considered: insulating boundary conditions and conducting boundary conditions. The former boundary condition reproduces the MHD results of previous studies, where the outflow of ions contribute to the MHD stabilizing properties of the system. However, with conducting boundary conditions it is shown that the outflowing ions do not contribute to the system's stability. In this case, which is likely to be physically relevant, the MHD stabilizing term only comes from the electron pressure in the expansion region, and the gas dynamic trap would not be as stable as previously envisioned. 15 refs., 1 fig.

27269 (DOE/ET/53088–425) **Nonlinear interaction of photons and phonons in electron-positron plasmas.** Tajima, T.; Taniuti, T. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Mar 1990. 45p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–425). Order Number DE90009341. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Nonlinear interaction of electromagnetic waves and acoustic modes in an electron-positron plasma is investigated. The plasma of electrons and positrons is quite plastic so that the imposition of electromagnetic (EM) waves causes depression of the plasma and other structural imprints on it through either the nonresonant or resonant interaction. Our theory shows that the nonresonant interaction can lead to the coalescence of photons and collapse of plasma cavity in higher (≥ 2) dimensions. The resonant interaction, in which the group velocity of EM waves is equal to the phase velocity of acoustic waves, is analyzed and a set of basic equations of the system is derived via the reductive perturbation theory. We find new solutions of solitary types: bright solitons, kink solitons, and dark solitons as the solutions to these equations. Our computation hints their stability. An impact of the present theory on astrophysical plasma settings is expected, including the cosmological relativistically hot electron-positron plasma. 20 refs., 9 figs.

27270 (DOE/ET/53088–427) **Extremal bounds on drift wave growth rates and transport.** Fowler, T.K. (California Univ., Berkeley, CA (USA). Dept. of Nuclear Engineering); Morrison, P.J. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Mar 1990. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–427). Order Number DE90009337. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A variational technique is used to obtain bounds on the growth constant γ versus wave number κ for plasma drift waves. We find, for $T_i = T_e$, $\gamma < \sqrt{2}\omega_* (1 + 3/\sqrt{2}\ \eta)$ in usual notation. This agrees closely with dispersion—relation results that have had good success in explaining global confinement times in tokamaks based on transport coefficients of the form (γ/κ^2). The present method is easier to calculate and results are of such general nature as to give greater assurance that nothing has been missed. The method is based on the time behavior of a free energy function that is chosen to be a constant of motion for an idealized Maxwellian plasma without currents, and almost constant for small departures from this ideal state. The underlying premise associating the variational technique with drift waves remains conjectural. 6 refs.

27271 (ENEA-RT-FUS–87-37) **Parametric instabilities excited by ion-sound and ion cyclotron quasi-modes in lower hybrid heating of tokamak plasmas.** Cesario, R.; Cardinali, A. ENEA, Frascati (Italy). Dipt. Fusione. 1988. 21p. (RT/FUS–87-37). Order Number DE90764339. Available from NTIS (US Sales Only), PC A03/MF A01.

Submitted to Nuclear Fusion.

The parametric decays of a lower hybrid (LH) pump are studied in a wide range of low-frequency quasi-modes which drive the instabilities. The numerical results of the parametric dispersion relation show that an ion-sound quasi-mode with frequency $omega_{1R}$ can excite a parametric instability with a growth rate greater than or equal to $omega_{1R}$, omega/sub/1R/much less than $omega_{ci}$ at the plasma edge, even at low power levels of the pump wave. In this condition, solutions can be found where the two LH sidebands can be resonant within a small frequency shift and both grow in instability. The estimated convective thresholds are in the range of rf power used for experiments on heating of tokamak plasmas. Such an instability can be related to the frequency broadening of the injected rf power observed during the LH additional heating experiments with the FT tokamak and other devices. The analysis in the range $omega_{1R}$ approx. l-$omega_{ci}$ shows that in the outer plasma region, ion-cyclotron quasi-modes can drive parametric instabilities where higher growth rates are found for l approx.=range 8-10 if a broadening of the launched parellel wave number is supposed. This kind of instability may explain the rf spectra observed during the high density plasma regimes, which show a typical non-monotonic envelope of the sideband peaks.

27272 (ENEA-RT-FUS–88-15) **A neutral particle analyser with a time of flight detection system providing a background rejection capability.** Betello, G.; Bracco, G.; Mantovani, S.; Tilia, B.; Zanza, V. ENEA, Frascati (Italy). Centro Ricerche Energia. Apr

1989. 24p. (RT/FUS–88-15). Order Number DE90764340. Available from NTIS (US Sales Only), PC A03/MF A01.

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A time of flight (TOF) detection system with a background noise rejection capability has been studied experimentally. A neutral particle analyser (NPA) with mass selection capability making use of several TOF detection system has been designed. The analyser should operate correctly in the high neutron flux of a large tokamak as jet with a neutron production rate in the order of 10^{19} neutrons/s.

27273 (ENEA-RT-FUS–88-16) **Stability of toroidicity induced drift waves in divertor tokamaks.** Briguglio, S.; Romanelli, F.; Bishop, C.M.; Connor, J.W.; Hastie, R.J. ENEA, Frascati (Italy). Centro Ricerche Energia. Apr 1989. 40p. (RT/FUS–88-16). Order Number DE90764341. Available from NTIS (US Sales Only), PC A03/MF A01.

Submitted to Physics Fluids.

The stability of toroidicity induced drift waves in a tokamak equilibrium with magnetic separatrix is studied both analytically and numerically. In particular, the task of a proper determination of the complex ballooning parameter is performed by solving the stationarity condition for the eigenvalue. Results show qualitative dependence on the location of the x-point in the meridian plane. Specifically, locating the x-point in the equatorial plane, both on the outside and on the inside of the plasma, causes a deepening of the well structure in the potential for the eigenmode thus enforcing the inhibition of the shear damping and the marginal stability result obtained in the circular magnetic surfaces case. On the other hand, the location of the x-point at the top of the plasma produces a flattening of the well, restores the shear damping and stabilizes the mode. A new quasi-marginally stable branch, corresponding to modes localized around the x-point, is shown to exist at high values of the separatric parameter k and x-point location close to the equatorial plane.

27274 (ENEA-RT-FUS–88-17) **Contributions to the international workshop on theory of fusion plasmas (Chexbres, 3–7 Oct 1988).** ENEA, Frascati (Italy). Dipt. Fusione. Apr 1989. 60p. (CONF-8810490–Exc.: International workshop on theory of fusion plasmas, Chexbres (Switzerland), 3 Oct 1988). Order Number DE90706076. Available from NTIS (US Sales Only), PC A04/MF A01.

Individual papers are indexed separately.

27275 (ENEA-RT-FUS–88-17, pp. 5-22) **Semicollisional microinstabilities in the presence of a magnetic separatrix.** Briguglio, S. (Associazione Euratom-ENEA sulla Fusione, Frascati (Italy)). ENEA, Frascati (Italy). Dipt. Fusione. Apr 1989. (CONF-8810490–Exc.: International workshop on theory of fusion plasmas, Chexbres (Switzerland), 3 Oct 1988). In *Contributions to the international workshop on theory of fusion plasmas (Chexbres, 3-7 Oct 1988).* Order Number DE90706076. Available from NTIS (US Sales Only), PC A04/MF A01.

In several auxiliary heated tokamaks, common features of experiments indicating an improved confinement regime, known as the H-mode, seem to be the presence of a magnetic separatrix quite close to the plasma boundary, the existence of a threshold in the edge electron temperature for the achievement of the mode, and the observation of electron density and temperature profiles which are rather flat over the whole radius with marked pedestals at the edge. These features indicate that the role of a good confinement region is possibly played by the region beyond the q=2 surface. Therefore, in order to understand the global confinement properties of the discharges, it is necessary to investigate the mechanisms which can determine the transport in such region. Due to the high edge temperature values, the role of microinstabilities in contributing to the anomalous transport coefficients may be important. This paper analyzes whether the stability of toroidal semicollisional modes, belonging to the electrostatic drift branch, destabilized by ion temperature gradients and trapped electron dynamics, may be affected by the presence of a magnetic separatrix. Graphs are developed which show instability thresholds for different magnetic surfaces.

27276 (ENEA-RT-FUS–88-17, pp. 23-42) **Propagation and absorption of lower hybrid waves in tokamaks.** Barbato, E. (Associazione Euratom-ENEA sulla Fusione, Frascati (Italy)). ENEA, Frascati (Italy). Dipt. Fusione. Apr 1989. (In Italian). (CONF-8810490–Exc.: International workshop on theory of fusion plasmas, Chexbres (Switzerland), 3 Oct 1988). In *Contributions to the international workshop on theory of fusion plasmas (Chexbres, 3-7 Oct 1988).* Order Number DE90706076. Available from NTIS (US Sales Only), PC A04/MF A01.

In the first part of this paper, a review is given of the linear theory of lower hybrid (LH) wave propagation and absorption utilized in numerical modelling of LHCD and heating experiments.Applications of a simple model to an Asdex current drive (CD) experiment at 1.3 GHz shows that 35% of the power has to be transferred to a high parallel refraction index (up to 5.5) to fit the experimental data. In order to minimize edge losses in heating experiments and maximize first pass absorption to preserve central deposition, it is suggested to use optimized spectra shaped as 1/parallel refraction index. After a brief discussion on the role of bulk and fast ion absorption, the second part of the paper deals with an extensive study of the variations of parallel refraction index along the rays when multiple wall reflections are included. An analytical mapping, based on the cold electrostatic model, describing such variations is derived. Good agreement is found between such mapping and the corresponding mapping, obtained by numerically integrating the full warm electromagnetic based model ray equations. As figure of merit, a parallel refraction index upshift factor is given in a dimensionless parameter space in which all the experiments can be represented. Finally a diffusion coefficient for parallel refraction index is derived under the hypothesis of stochastic reflection angles.

27277 (ENEA-RT-FUS–88-17, pp. 51-60) **Toroidal semicollisional microinstabilities and anomalous electron and ion transport.** Romanelli, F. (Associazione Euratom-ENEA sulla Fusione, Frascati (Italy)); Briguglio, S. ENEA, Frascati (Italy). Dipt. Fusione. Apr 1989. (CONF-8810490–Exc.: International workshop on theory of fusion plasmas, Chexbres (Switzerland), 3 Oct 1988). In *Contributions to the international workshop on theory of fusion plasmas (Chexbres, 3-7 Oct 1988).* Order Number DE90706076. Available from NTIS (US Sales Only), PC A04/MF A01.

Tokamak plasmas are characterized by strongly anomalous particle and thermal fluxes. Microinstabilitybased models have been proposed in the past in order to explain such anomalies. These models rely on the effect of the semicollisional microinstabilities destabilized by trapped electrons and ion temperature gradients. Numerical simulations have shown good agreement with the experimentally determined trends of the global confinement time. In this paper, the problem of the stability of eta_i modes, in the presence of the nonadiabatic electron response associated to the trapped particle dynamics, is reconsidered.

27278 (ENEA-RT-FUS–89-01, pp. 13-16) **Analysis of high-frequency magnetic fluctuations on the FT tokamak.** Crisanti, F. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)); Marinucci, M.; Nardone, C. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13-17 May 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

The magnetic signals of the FT tokamak at the plasma edge were investigated. The spectra observed for most of the signals examined showed a low-frequency part characterized by a strong peak at about the Mirnov frequencies sometimes accompanied by the second and third armonic peaks. The high-frequency part had a fairly typical broadband incoherent aspect and exhibited an f-alpha dependence from about 20 kHz to 200 kHz. With regard to scaling with main plasmas parameters, more than 200 shots in hydrogen or deuterium plasma were considered, widely distributed over the space of the main plasma parameters. The amplitude of the signals, mainly high at frequency (> 20 kHz), was found to be very sensitive to the plasma position. The fluctuation amplitude at the high frequency regime (20/50 kHz) exhibited no dependence

on the avarage plasma density for all the values of the plasma current. This allowed the study of the scaling with the plasma current taking into account all the selected shots. A clear dependence of the high-frequency amplitude on the plasma current resulted, but, even more evidently, the type of dependence appeared correlated with the toroidal field. In order to detect the possible existence of a strange attractor due to the nonlinear interaction of a limited number of coherent modes, the correlation dimensions of the magnetic signals were calculated for all the selected shots by means of the Grassberger-Procaccia algorithm. In most of the shots analysed, no saturation of the correlation exponent for increasing values of embedding space dimension could be found.

27279 (ENEA-RT-FUS–89-01, pp. 17-20) **Ignition domain and plasma burn control.** Apruzzese, G. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)); Tanga, A. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

A tokamak fusion reactor should ignite at low powers and operate at high powers without thermal instability. The properties of the ignition domain and plasma thermal stability are analyzed with a zero dimensional model whose basic features are those of the POPCON code. A mechanism of stabilizing the reactor operating region, based on the control of energy confinement sensitive parameters such as plasma current, is presented. The study of ignited plasma for a given device shows that the operational domain depends strongly on the confinement model. Ignited plasma is always thermally unstable up to the upper temperature limit with a characteristic time which is a function of the energy confinement time. A mechanism of stabilizing plasma burn could be a feedback based on the control of plasma current.

27280 (ENEA-RT-FUS–89-01, pp. 25-29) **Helium plasmas results in ohmic FT discharges.** Bracco, G. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)). ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

In the Frascati FT tokamak (Italy), a series of plasma discharges with helium as the filling gas was carried out in the range $3<q<6$, $0.5<n<2.5*10^{14}$ cm^{minus3} at B=6T where q is the safety factor at the limiter, n is the line averaged density and B toroidal field. The main task of the helium operation was the study of the dependance of both the limits of tokamak operation and the scalings of the main plasma parameters on the ion mass/charge. The use of helium as the filling gas did not present major operational problems. The electron temperature profile was measured by Thomson scattering. In deuterium discharges performed in the same period, the peak electron temperature was found to depend linearly on the parameter $B^{1-3}/q^{0.4}n^{0.6}$. The peak electron temperature for deuterium and helium was shown as a function of the previous parameter and indicated that the He discharges have a 20% higher value compared to deuterium. The ratio between peak electron temperature and average volume was shown as a function of q and indicated no relevant difference between deuterium and helium. The sawtooth period was also similar in deuterium and helium discharges at the same q and density. The plasma resistive voltage, 20% higher for He discharges than in comparable deuterium plasmas, provided increased ohmic input power. The overall comparison between helium and deuterium discharges in the FT tokamak showed a similarity between the two species which seems to be stronger in the tokamak than in other tokamaks where both gases have been used.

27281 (ENEA-RT-FUS–89-01, pp. 33-36) **Parametric decay of lower hybrid waves.** Cardinali, A. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)); Cesario, R.; Paoletti, F. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

A crucial feature of all the experiments concerning the lower hybrid current drive and heating of tokamaks is that there exists a strong density threshold beyond which the current cannot be driven if the r.f. power exceeds a certain value. It is possible that at higher operating densities the lower hybrid waves excite parametric instabilities well before reaching the centre, with the consequence that the current drive can be inhibited due to the fact that instead of goingto the electrons in the tail distribution, wave momentum and energy are diverted elsewhere. During recent experiments, the reduction of the efficiency of the current drive or heating was associated with a typical activity of the r.f. pro be signals observed when the plasma density and the r.f. power exceed the threshold value. Studies are being conducted on the possible role of the parametric instabilities in the next lower hybrid current drive experiments on ASDEX. This paper presents the results of the study of parametric instabilities obtained by solving the complete parametric dispersion relation numerically, and considering, for the typical plasma parameters, a wide range of frequencies which involve different channels of instabilities.

27282 (ENEA-RT-FUS–89-01, pp. 37-40) **Fast crash and dependence of sawteeth on transport coefficients from reduced MHD simulations.** Vlad, G. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)); Bondeson, A. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

Numerical simulations of sawteeth, generally consistent with the Kadomtsev model, have been performed by several different groups. However, all computations carriet out so far have been made with plasma parameters far from those characteristic of current experiments. In this paper, we present self-consistent simulations over a wide range of plasma parameters to obtain the dependence of characteristic features of the sawteeth on the transport coefficients. The simulations are based on the standard, straight cylinder, low-beta, reduced-MHD equations with self- consistent evolution of the electron temperature, including a highly anisotropic thermal diffusivity and ohmic heating. Comparison of the simulation results concerning, e.g., period, growth-time of the instability and collapse time, with experimental data shows excellent agreement for Lundquist numbers up to about 10^7 (corresponding to machines of the size of Frascati tokamak, FT). An important effect found in these self-consistent simulations is that the current profile is significantly modified by the sawteeth, leading to a very flat distribution in a central region accompaneid by a sharp drop outside the reconnection layer. This profile makes it possible to turn on the resistive kink instability with a large growth-rate by a minute change in central safety factor. Thus, the Kadomtsev model, with some modification of the current profile, appears to describe the sawtoothing in, at least, small and medium sized tokamaks very well.

27283 (ENEA-RT-FUS–89-01, pp. 41-44) **Influence of energetic ion population on tokamak plasma stability.** White, R.B. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)); Romanelli, F.; Bussac, M.N. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

Recent experiments in JET have indicated that an energetic particle component has a strong stabilizing influence of sawtooth oscillations. The high energy particles, by precessing faster than the growth rate of the mode, average the potentials associated with the perturbation and give rigidity to the plasma. Investigations of the fishbone mode, showed that the ideal internal kink mode can

be completely stabilized. More recently, the stabilizing influence of the resistive internal kink mode was demonstrated and a domain of operating parameters was found such that both the resistive internal kink and the fishbone mode are stable. In order to understand the relation with different analyses, this paper investigates different limits of the dispersion relation which results by considering the plasma to consist of two components, a warm background treated with resistive MHD, and a low density hot component treated with the gyrokinetic formalism.

27284 (ENEA-RT-FUS–89-01, pp. 49-52) **Numerical simulation of toroidal ion temperature gradient turbulence.** Ottaviani, M. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)); Romanelli, F.; Benzi, R.; Briscolini, M.; Santangelo, P.; Succi, S. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

Small scale turbulence induced by the combined effect of ion temperature gradients and unfavourable magnetic curvature is commonly considered a strong candidate for explaining the high density saturation of ohmic confinement time. Anomalous transport models are generally based on turbulent transport coefficients obtained from quasilinear theory together with a mixing length estimate of the fluctuation level. In this work, extensive numerical simulations of ion temperature gradient turbulence were performed in order to investigate the validity of simple analytical estimates, as well as the scaling of heat transport with the relevant plasma parameters, such as forcing and dissipation. The fluid model of the nonlinear evolution of ion temperature gradient modes was derived directly from the Braginskij equations. Graphs were developed in which the grid averaged heat flux was plotted versus time for varying dissipation and forcing.

27285 (ENEA-RT-FUS–89-01, pp. 53-56) **Absorption of LH waves by fusion-generated a-particles.** Barbato, E.; Santini, F. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma pphysics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

The alpha-particle population in an ignited plasma could deteriorate the current drive efficiency of lower hybrid (LH) waves in a steady state reactor. In fact, due to the high energy production, alpha-particles may interact with the LH waves and reduce the absorption by electrons. This effect is absent if the frequency is high enough (10 GHz for ITER like parameters). Nevertheless, the technical difficulties of using such a high frequency, necessitate investigating whether the absorption by alpha particles may be negligible for ITER parameters at relatively lower frequencies also. Since the quasilinear diffusion exceed the collisional drag, the complete equation for the alpha-distribution function(df) was studied and is reported in this paper. The consequent wave absorption by alpha particles is supplemented by a 1-D deposition code which includes wave propagation and absorption.

27286 (ENEA-RT-FUS–89-01, pp. 57-60) **Ion Bernstein wave heating of high density plasmas with waveguide antennas.** Cardinali, A. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)); Cesario, R.; De Marco, F.; Ono, M. ENEA, Rome (Italy). Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

Ion Bernstein wave heating (IBW) of high density plasmas, seems to be particularly indicated for tokamak-like reactor devices because, owing to the dimensions of these devices, the power carried by the wave can be coupled to the plasma by a waveguide antenna which can fit between the toroidal coils of the tokamak. Calculationson the propagation, absorption and coupling have been presented for the Frascati Tokamak Upgrate (FTU) which seems to be very well indicated for an IBW heating experiment by a waveguide coupler with f=433 MHz and P=1.5 MW. The ions of a hydrogen plasma would be directly heated at the fourth ion-cyclotron harmonics near the plasma centre.

27287 (ENEA-RT-FUS–89-01, pp. 65-68) **Microinstabilities in FT tokamak.** Frigione, D. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)); Goetsch, S. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

The present study of density fluctuations relative to the FT tokamak can be summarized in three points: (a) the mean square relative fluctuation level in the measured range (2-5 cm^{minus1}; 10-1000 kHz) is linearly correlated with the inverse confinement time (te) in the low nq (line average density times safety factor at the limiter) region where te is linear. At higher nq values, in coincidence with the saturation of te, the fluctuations start to increase and the correlation is lost. (b) RF heating power at LHR does not usually produce any effect on the CO_2 scattering signal: in some low density shots a modification of the frequency spectrum is observed. (c) An analysis, using bandpass rms detectors convering the frequency range 10-100 kHz and recorded during the whole discharge, of the signal show a high dimensionality confirming the high turbulent nature of the phenomenon.

27288 (ENEA-RT-FUS–89-01, pp. 73-76) **High resolution spectroscopy on the Frascati tokamak FT.** Bartiromo, R. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)); Bombarda, F. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

The bent crystal spectrometer installed on the Frascati tokamak (FT), a high resolution (lambda/delta-lambda approx.=20000) instrument of the Johann type, was fitted with a crystal (quartz 213), suitable for observing the high ionization stages of chromium 23, to test the accuracy of calculated atomic data and to diagnose plasma. This paper reports only the observations relevant to fusion plasma diagnostics. The spectrum between 2.085 and 2.120 A was recorded over a series of discharges of 8 T of magnetic field, range 300-350 kA of plasma current, 3.0 plus /minus 10% of electron temperature and an average density of 3 to 7 10^{13} cm^{minus3}. It has already been suggested that the intensity ratio, R, between a dielectronic recombination satellite line and the optically allowed resonance line is not only a function of electron temperature only, but it can also provide a means of detecting the presence of suprathermal tails in the electron distribution function. This observation was used, in the case of chromium 23, to develop plots of suprathermal electron fractional density versus the relative deviation of R for different temperatures. The cylindrically bent crystal spectrometer is characterized by a sensibly higher throughput then a flat crystal instrument. The spectrally resolved image line, however, gives no information on the spatial distribution of the emitting source, due to the astigmatic imaging of the reflected rays in the plane perpendicular to the diffraction plane. In order to obtain a space resolved image along the poloidal section of the tokamak, two horizontal slits were used, although00000NUA 0100289 450000100

27289 (ENEA-RT-FUS–89-01, pp. 77-80) **Thermal flux asymmetries in the FT edge plasma.** Ciotti, M. (Assocaizione EURATOM-ENEA sulla Fusione, Frascati (Italy)); Ferro, C.; Maddaluno, G. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

A magnetized plasma loses energy through two main channels:by radiation diffusing uniformly to the vacuum chamber enclosing the plasma and by means of particles flowing along flux tubes to localized zones of the chamber. A knowledge of the relative amount of the two channels as function of the plasma parameters is important for formulating models of the scrape-off layer (SOL) and for developing credible designs of the structures necessary to control the plasma (limiters/divertor plates) and improve the plasma performances (launcher structures for auxiliary heating). The best method for investigating the thermal loads is surface thermography by infrared techniques, which can provide spatially and temporally resolved information during a discharge. When, as in FT tokamak, the machine's compactness rules out this possibility, set of thermocouples distributed in different zones in the vacuum chamber can be conveniently used to measure the total energy deposited per discharge in different zones. In FT we have used this philosophy by inserting thermocouples in the vacuum chamber, the limiter and in other structures. Some experimental results have already been presented and in this paper we report data obtained from two thermocouples embedded in the protective plates of the RF launcher structure.

27290 (ENEA-RT-FUS–89-07) **Measurement and analysis of neutron sawteeth in FT tokamak.** Batistoni, P.; Rapisarda, M.; Anderson, D. ENEA, Frascati (Italy). Centro Ricerche Energia. Sep 1989. 25p. (RT/FUS–89-7). Order Number DE90764343. Available from NTIS (US Sales Only), PC A03/MF A01.

Submitted to Nuclear Fusion.

The time evolution of fusion neutron emission was measured in sawtoothing discharges in the FT tokamak. The observed charge in neutron emission level during the sawtooth crash was studied in terms of the variations of deuteron density and temperature. In addition to the changes in the peak values of these quantities, profile changes were also considered. It was shown that a net ion energy outflow through the mixing radius must occur after the crash, in order to explain the observed drops in the neutron emission.

27291 (IPP–III/145) **Microwave plasma generation with slotted-line radiator structures.** Lisitano, G. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). May 1989. 12p. (CONF-890956–: 9. international symposium on plasma chemistry and plasma equipment exhibition, Pugnochiuso (Italy), 4-8 Sep 1989). Order Number DE90767377. Available from NTIS (US Sales Only), PC A03/MF A01.

Simple and economic production of plasma can be achieved over a wide range of plasma parameters by exciting electrodeless, slotted-line radiating structures with microwave power. These plasma sources, which originate from fusion research, are suitable for applications in both low-temperature and thermal plasma chemistry. (orig.).

27292 (JET-R–89-11) **A general method for measuring the scattering matrices of N-port systems.** Bizarro, J.P. (JNICT, Centro de Electrodinamica, IST, Lisbon (Portugal)); Pain, M. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. 1989. 17p. Order Number DE90622425. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Arising from the need to test the multijunctions that will build up the JET (Joint European Torus) lower hybrid antenna, a general model to measure scattering matrices of microwave devices was developed. The model allows for devices with any number of ports and for the use of adaptors between the measuring system and the device under test. Its accuracy can be as good as 1% for waveguide components. (author).

27293 (LA–11757-MS) **Fusion burn dynamics in dense Z-pinch (DZP).** Krakowski, R.A. Los Alamos National Lab., NM (USA). Apr 1990. 78p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. Order Number DE90007976. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

The fusion burn dynamics and energy yield of the dense Z-pinch (DZP) are examined using a profile-averaged, zero-dimensional, time dependent model. A range of conditions (fuel, line density, voltage, fusion-product heating, enthalpy endloss, density and temperature profiles, current rise rate, electrode impurities) are examined. Magneto-hydrodynamic stability is assumed, and initial conditions are based on those ideally existing after the melting and ionization of a solid fiber of fusion fuel. Plasma conditions required of neutron sources for materials testing ($\dot{S}_n \geq 10^{19}$ n/s) and for possible commercial power production (ratio of fusion energy yield to energy input, $Q_p \simeq 15$, lower values if reversible recovery of a fraction of the magnetic energy is possible) are described. If $f_B \gtrsim 0.8$ fractional fuel burnup is possible in a nominal 800-ns DT discharge (200-ns current-rise phase at 20 MV/m followed by a 500-ns constant-current crowbarred phase), reactor-relevant values of Q_p may be possible. For the simpler (and shorter) constant-voltage discharge (e.g., no voltage crowbar) the value of Q_p is in the range 5–10 for discharges below 200-ns duration. Smaller levels of fuel burnup, shorter discharges, or generally lower levels of Q_p will require a reversible energy transfer system to meet reactor energy-balance requirements. Imposition of a plasma current rise-time constraint that may be needed for stable plasma operation (e.g., $I > 10^{12}$ A/s) will burnup, Q_p and discharge time to an extent where reversible energy/transfer system will be required to meet reactor energy- balance requirements. 25 refs.

27294 (LRP–343/88) **Measurement of magnetic fluctuations in the JET and TCA tokamaks.** Duperrex, P.A. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Nov 1988. 169p. Order Number DE90620583. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The analysis of magnetic fluctuations in the JET and TCA tokamaks has been focused for this thesis on three subjects: (i) magnetic turbulence and its correlation with the degradation of energy confinement (ii) magnetic perturbation associated with the sawtooth (iii) analysis of the magnetic coherent activity associated with stable locked-mode. The spatial structure of the turbulent magnetic activity has been investigated in JET and it is shown that the turbulent fluctuations are strongly correlated along the equilibrium magnetic field with $k.B_o \approx 0$. In TCA and JET, the level of magnetic fluctuations is observed to increase when the energy confinement time decreases. The analysis of a magnetic perturbation - the gong - appearing at the time of the sawtooth instability growth showed that the gong is in fact the magnetic signature of the instability itself. Different types of analysis are proposed which could improve our understanding of the sawtooth instability. The analysis of the coherent magnetic fluctuations allowed to deduce a toroidal plasma rotation and to estimate the radial ambipolar electric field. The results for TCA and JET are comparable with measurements performed in other tokamaks. It has been possible to show the existence of a new type of magnetic oscillations which is present during the stable phase of a locked-mode. This mode is resonant at the edge with n=1, $m \approx int(q(a))$ and has been interpreted as an interchange mode destabilized by the new helical structure due to the locked-mode. (author) 93 figs., 4 tabs., 141 refs.

27295 (LRP–347/88, pp. 5-8) **Kinetic and current profile effects of Alfven waves in the TCA tokamak.** Borg, G.G. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Howling, A.A.; Joye, B.; Lister, J.B.; Ryter, F.; Weisen, H. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). May 1988. (CONF-880534–: 15. European Physical Society plasma physics division conference on controlled fusion and plasma heating, Dubrovnik (Yugoslavia), 16-20 May 1988). In *Papers contributed to the 15. european conference on controlled fusion and plasma heating.* Order Number DE88010580. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Results have been presented which show clear evidence that certain effects of Alfven waves cannot be explained by the simple quiescent cold plasma MHD theory. Kinetic effects must be included to fully describe th standing KAWs observable in the edge plasma wavefield. Current or density profile wobulation appears the best candidate to explain the low observed Q. Static current profile changes occuring at continuum thresholds seem the best candidate to explain a markedly reduced DAW loading in experiments where the spectrum is reswept by a descending density. (author) 5 figs., 5 refs.

27296 (LRP–347/88, pp. 1-4) **Alfven wave coupling in large tokamaks.** Borg, G.G. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Knight, A.J.; Lister, J.B.; Appert, K.; Vaclavik, J. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). May 1988. (CONF-880534–: 15. European Physical Society plasma physics division conference on controlled fusion and plasma heating, Dubrovnik (Yugoslavia), 16-20 May 1988). In *Papers contributed to the 15. european conference on controlled fusion and plasma heating.* Order Number DE88010580. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Supplementary plasma heating by Alfven waves (AWH) has been extensively studied both theoretically and experimentally for small, low temperature plasmas. However, only a few studies of AWH have been performed for fusion plasmas. In this paper the cylindrical kinetic code ISMENE is used to address problems af AWH in a large tokamak. The results of calculations are presented which show that the antenna loading scales with frequency and vessel dimensions according to ideal MHD theory. A sample scaling of the experimental antenna loading measured in TCA to the loading predicted for a fusion plasma is presented. We discuss whether this loading leads to a realistic antenna design. The choice of a suitable antenna configuration, mode number and operating frequency is presented for NET parameters with a typical operating scenario. (author) 6 figs., 8 refs.

27297 (LRP–347/88, pp. 9-12) **Alfven wave heating and its effect on the tokamak current profile.** Dudok de Wit, T. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Howling, A.A.; Joye, B.; Lister, J.B. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). May 1988. (CONF-880534–: 15. European Physical Society plasma physics division conference on controlled fusion and plasma heating, Dubrovnik (Yugoslavia), 16-20 May 1988). In *Papers contributed to the 15. european conference on controlled fusion and plasma heating.* Order Number DE88010580. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The aim of this paper is to interpret the effect of Alfven Wave Heating (AWH) on current, density and temperature profiles of the TCA tokamak plasma. AWH is accompanied by significant increases in line-averaged density n_e and $(\beta_p + l_i/2)$, where $(\beta_p + L_i/2)$ is deduced from the equilibrium values of plasma current and vertical field (after correcting for the vertical field penetration L/R time of 1.1 ms for the vacuum vessel). For given plasma conditions, the value of $(\beta_p + l_i/2)$ does not depend sensitively on the exact major radius of the plasma (determined by using different position feedback methods which controlled the magnetic axis or the outermost flux surface). We therefore have confidence in the accuracy of the $(\beta_p + l_i/2)$ measurement. (author) 1 fig., 9 refs.

27298 (LRP–347/88, pp. 13-16) **Effects of the Alfven wave heating on the TCA plasma studied by the dynamical response.** Joye, B. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Lister, J.B.; Moret, J.M. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). May 1988. (CONF-880534–: 15. European Physical Society plasma physics division conference on controlled fusion and plasma heating, Dubrovnik (Yugoslavia), 16-20 May 1988). In *Papers contributed to the 15. european conference on controlled fusion and plasma heating.* Order Number DE88010580. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Studies of the dynamical response of the plasma to modulated Alfven Wave Heating (AWH) power and to modulated gas puffing in ohmic conditions have been performed on TCA. In both cases, the radial profile of the phase of the electron temperature response exhibits a low value inside the q=1 radius, indicating the presence of a central thermal energy source. Absolute comparison of the gain and the phase in the two cases leads to the conclusion that the electron temperature perturbation during AWH is dominated by the influence of the density variation, with a peaked kinetic energy modulation profile. This at least partly explains the previously reported high performances of the AWH results. (author) 2 figs., 5 refs.

27299 (LRP–347/88, pp. 17-20) **Shafranov parameter limits for ohmic and R.F. heated plasmas in TCA.** Joye, B. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Lister, J.B.; Ryter, F. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). May 1988. (CONF-880534–: 15. European Physical Society plasma physics division conference on controlled fusion and plasma heating, Dubrovnik (Yugoslavia), 16-20 May 1988). In *Papers contributed to the 15. european conference on controlled fusion and plasma heating.* Order Number DE88010580. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An ohmic study is presented to define the experimental dependence of the value of $(\beta + l_i/2)$ derived from the Shafranov equation. The Alfven Wave Heating pulse causes an increase in both $(\beta + l_i/2)$ and density, and with R.F., the value of $(\beta + l_i/2)$ is significantly greater than the ohmic scaling. However, the maximum R.F. values never exceed the maximum achieved ohmic values. As this limit is approached, the m=2 activity increases, as in the ohmic case, and we show that this increase correlates well with the increase in $(\beta + l_i/2)$. (author) 5 figs., 2 refs.

27300 (LRP–347/88, pp. 21-24) **Ion temperature evolution during Alfven wave heating in TCA.** Chambrier, A. de (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Duval, B.P.; Lister, J.B.; Mompean, F.J.; Moret, J.M. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). May 1988. (CONF-880534–: 15. European Physical Society plasma physics division conference on controlled fusion and plasma heating, Dubrovnik (Yugoslavia), 16-20 May 1988). In *Papers contributed to the 15. european conference on controlled fusion and plasma heating.* Order Number DE88010580. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The application of Alfven Wave Heating (AWH) is accompanied by an electron density (n_e) rise and an increase in the ion temperature (T_i) measured with a Neutral Particle Analyser (NPA). A study was performed and a formula developed to model the T_i in non stationary ohmic discharges, to determine if the T_i increase is simply due to n_e. When compared with AWH discharges, the observed T_i is consistently higher than predicted by the ohmic model, indicating an additional source due to the RF. T_i also reflected the evolution of the AW spectra and reaches a maximum at the onset of a new continuum ie: when the resonant surfaces are in the outer half of the minor radius. T_i was investigated with modulated RF power, and a modulated gas puff, measuring the phase and amplitudes of the T_i rise relative to the perturbation. We conclude that the RF appears to have a direct effect on the T_i. (author) 3 figs., 5 refs.

27301 (LRP–347/88, pp. 25-28) **Influence of the Alfven wave spectrum on the scrape-off layer of the TCA tokamak.** Martin, Y. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Hollenstein, Ch. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). May 1988. (CONF-880534–: 15. European Physical Society plasma physics division conference on controlled fusion and plasma heating, Dubrovnik (Yugoslavia), 16-20 May 1988). In *Papers contributed to the 15. european conference on controlled fusion and plasma heating.* Order Number DE88010580. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The study of the Scrape-Off Layer (SOL) during Alfven wave heating may lead to a better understanding of the antenna-plasma interaction. The SOL of the TCA tokamak has been widely investigated by means of Langmuir probes. The aim of the present work is to present in detail the influence of the Alfven wave spectrum on the SOL. The experiments have shown that the plasma boundary layer is strongly affected by the RF, in particular the ion density, the electron temperature and the floating potential. In TCA, as the spectrum evolves due to a density rise, the passage of the Alfven continua and their associated eigenmodes (DAW) induces a strong depletion in the edge density of up to 70% during the continuum part and a density increase during the crossing of an eigenmode. The floating potential becomes negative during the continua and even more negative crossing the eigenmodes. This behaviour changes as a function of the power transmitted to the plasma through the antennae, especially we have found with MHD modes a change around 100 kW. The profiles of the basic parameters are modified, depending on the wave spectrum. MHD mode activity

which can occur during the RF phase considerably alters the behaviour mentioned above. Finally, the modulation of the RF power allows us to characterize the difference in coupling, for the continua and the eigenmodes, between the Alfven wave field and the scrape-off layer. (author) 5 figs., 6 refs.

27302 (LRP–347/88, pp. 29-32) **Magnetic measurements of the sawtooth instability in JET.** Duperrex, P.A. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Pochelon, A.; Edwards, A.; Granetz, R.; Snipes, J. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). May 1988. (CONF-880534–: 15. European Physical Society plasma physics division conference on controlled fusion and plasma heating, Dubrovnik (Yugoslavia), 16-20 May 1988). In *Papers contributed to the 15. european conference on controlled fusion and plasma heating.* Order Number DE88010580. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Magnetic coil signals are used to obtain the toroidal mode number spectrum of the sawtooth instability in a small-aspect-ratio tokamak. The excellent correlation between the edge (magnetic) displacement and the core displacement (soft X-ray tomography) demonstrates the validity of this approach and makes magnetic coil measurements an appropriate tool for studying the sawtooth instability global wavefunction. (author) 2 figs., 4 refs.

27303 (LRP–347/88, pp. 33-36) **Simulation of plasma control in the TCV tokamak with high frequency stabilization.** Marcus, F.B. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Hofmann, F.; Keller, R.; Lister, J.B.; Marmillod, Ph.; Perez, A.; Tonelli, G.; Jardin, S.C. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). May 1988. (CONF-880534–: 15. European Physical Society plasma physics division conference on controlled fusion and plasma heating, Dubrovnik (Yugoslavia), 16-20 May 1988). In *Papers contributed to the 15. european conference on controlled fusion and plasma heating.* Order Number DE88010580. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The Tokamak Simulation Code (TSC) is used to study evolution, control, and growth rates of resistive, axisymmetric instabilities in the TCV (Tokamak a Configuration Variable). TCV is currently under construction. Its parameters are: B=1.43T, R=0.87m, a=0.24m, b/a up to 3/1, Ip up to 1200 kAmp. The axisymmetric resistive growth rate is calculated for various equilibria passively stabilized by the TCV vacuum vessel. There exists a range of plasmas which are ideally stable, but which have resistive growth rates greater than those which can be controlled with 100 Hz, 12 pulse thyristor power supplies. We are able to control these high growth rate plasmas by producing a fast, relatively low power radial flux using coils inside the vacuum vessel. Detailed TSC evolutions showing the response of the plasma to these combined control and shaping coils are presented. (author) 4 figs., 3 refs.

27304 (LRP–347/88, pp. 37-40) **Integro-differential equation approach to electrostatic wave problems in ICRF.** Sauter, O. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Vaclavik, J. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). May 1988. (CONF-880534–: 15. European Physical Society plasma physics division conference on controlled fusion and plasma heating, Dubrovnik (Yugoslavia), 16-20 May 1988). In *Papers contributed to the 15. european conference on controlled fusion and plasma heating.* Order Number DE88010580. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We solve the linear electrostatic wave equation for an inhomogeneous bounded plasma in an inhomogeneous magnetic field using a hot model valid to all orders in Larmor radius. This leads us to solving a homogeneous second order integro-differential equation with two boundary conditions. Thus we are able to find wave solutions, for any given density and temperature profiles, having wavelengths even smaller than the Larmor radius. (author) 3 figs., 4 refs.

27305 (LRP–347/88, pp. 41-44) **Ballooning instabilities in tokamaks with sheared toroidal flows.** Cooper, W.A. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). May 1988. (CONF-880534–: 15. European Physical Society plasma physics division conference on controlled fusion and plasma heating, Dubrovnik (Yugoslavia), 16-20 May 1988). In *Papers contributed to the 15. european conference on controlled fusion and plasma heating.* Order Number DE88010580. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Because ballooning instabilities can impose a limit on the beta value that can be achieved in tokamak devices, it is important to determine what impact plasma rotation and velocity shear can have on the stability properties of the plasma. Previous theoretical studies of ballooning modes in toroidal devices have suggested that the ballooning mode formalism described either through Weyl sequences or with the covering space concept breaks down when the velocity shear in the toroidal flow is finite. In this work, the covering space concept is employed to represent ballooning mode structures that vary slowly along the magnetic field lines but rapidly across them. (author) 2 figs., 7 refs.

27306 (LRP–386/89, pp. 2) **Experimental study of a quasi-optical gyrotron operating at the fundamental frequency.** Hogge, J.P. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Alberti, S.; Tran, M.Q.; Perrenoud, A.; Tran, T.M.; Isaak, B.; Bondeson, A.; Joedicke, B.; Mathews, H.G. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). Oct 1989. (CONF-8910353–: 14. international conference on infrared and millimeter waves, Wuerzburg (Germany, F.R.), 2 Oct 1989). In *Invited and contributed papers presented at the 14. International conference on infrared and millimeter waves.* Order Number DE90706060. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The Centre de Recherches en Physique des Plasmas (CRPP) is developing a 100 GHz ($\omega=\Omega_{ce}$) Quasi-Optical (Q.O) gyrotron. Powers higher than 90 kW at an efficiency of about 12% were recorded. Depending on the electron beam parameters, the frequency spectrum of the output can be either single-moded or multi-moded. One of the main advantage of the Q.O gyrotron is its frequency tunability. We have tested various techniques to tune the output frequency, such as changing the mirror separation, the beam voltage or the main magnetic field. Within the limitations of the present set-up, 5% tunability was achieved. (author) 6 figs., 4 refs.

27307 (LRP–386/89, pp. 2) **Second harmonic emission of a quasi optical gyrotron: experimental results.** Alberti, S. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Tran, M.Q.; Hogge, J.P.; Tran, T.M.; Bondeson, A.; Muggli, P.; Isaak, B.; Joedlicke, B.; Mathews, H.G. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). Oct 1989. (CONF-8910353–: 14. international conference on infrared and millimeter waves, Wuerzburg (Germany, F.R.), 2 Oct 1989). In *Invited and contributed papers presented at the 14. International conference on infrared and millimeter waves.* Order Number DE90706060. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A quasi-optical (Q.O) gyrotron designed for operation at the fundamental (Ω_{ce}=100 GHz) exhibits simultaneous emission at Ω_{ce} and $2\Omega_{ce}$. For a beam current of 4A, 20% of the total RF power is emitted at $2\Omega_{ce}$. In order to understand the influence of the presence of the second harmonic on the operation at the fundamental, an extensive set of measurement has been carried out. A comparison with a theoretical model will be presented. (author) 5 figs., 3 refs.

27308 (LRP–386/89, pp. 2) **Harmonic emission in quasi-optical gyrotrons.** Tran, T.M. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Bondeson, A.; Alberti, S.; Tran, M.Q. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). Oct 1989. (CONF-8910353–: 14. international conference on infrared and millimeter waves, Wuerzburg (Germany, F.R.), 2 Oct 1989). In *Invited and contributed papers presented at the 14. International conference on infrared and millimeter waves.* Order Number DE90706060. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In a quasi-optical resonator, the quality factor Q is an increasing function of the frequency. As a result, the harmonic content in the output of a high power quasi-optical gyrotron, designed to operate at the fundamental, is expected to be important. Utilizing the slow

time scale single particle model, the competition between the fundamental and higher harmonics has been investigated numerically. Small signal as well as nonlinear calculations will be presented. The results can be applied to the design of quasi-optical gyrotrons with high power emission at the second or higher harmonics. (author) 1 fig., 4 refs.

27309 (LRP–386/89, pp. 2) **Low power measurement of power coupling out of Fabry-Perot resonator at mm wavelengths. Comparison between some techniques.** Hogge, J.P. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Perrenoud, A.; Tran, M.Q.; Alberti, S.; Isaak, B.; Muggli, P.; Tran, T.M. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). Oct 1989. (CONF-8910353–: 14. international conference on infrared and millimeter waves, Wuerzburg (Germany, F.R.), 2 Oct 1989). In *Invited and contributed papers presented at the 14. International conference on infrared and millimeter waves.* Order Number DE90706060. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Three different ways of coupling energy out of a large Fabry-Perot resonator have been tested at frequencies around 120 GHz, in the frame of quasi-optical gyrotron development. Coupling through annular slots in one of the mirrors, Cassegrain coupling and power extraction through a mirror performated with parallel slits acting as a strip grating have been compared after propagation in a strongly overmoded circular waveguide by measuring the field pattern at different positions. (author) 5 figs., 1 ref.

27310 (LRP–386/89, pp. 2) **Multimode simulation of free-electron-laser oscillators.** Tran, T.M. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Dietrich, D. Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland). Oct 1989. (CONF-8910353–: 14. international conference on infrared and millimeter waves, Wuerzburg (Germany, F.R.), 2 Oct 1989). In *Invited and contributed papers presented at the 14. International conference on infrared and millimeter waves.* Order Number DE90706060. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The nonlinear evolution of a free-electron-laser (FEL) oscillator is investigated numerically for a configuration in which the FEL gain per pass in a high Q optical resonator is low. In this configuration, the number of passes required to reach the nonlinear saturation can be very large. In order to reduce the computer time, a formulation in which the discrete pass number is transformed to a continuous slow time variable is used. Preliminary results will be presented for the case where the 2-D effects (diffraction, betatron oscillations) are neglected. (author) 2 refs.

27311 (ORNL/TM–11453) **Overview of recent results from the Advanced Toroidal Facility.** Murakami, M.; Anabitarte, E.; Anderson, F.S.B.; Bell, G.L.; Bell, J.D.; Bigelow, T.S.; Carreras, B.A.; Charlton, L.A.; Clark, T.L.; Colchin, R.J. Oak Ridge National Lab., TN (USA). Feb 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010229. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An overview of recent experimental results from the Advanced Toroidal Facility (ATF) is presented. Beam-heated plasmas with $\bar{n}_e$ of 10^{20} m^{-3} and $\tau_{E^{SS}}$ of $\approx$ 20 ms have been achieved. Thermal collapse of the plasmas is mitigated by wall conditioning and particle fueling. Confinement time scales positively with density and magnetic field, offsetting deterioration with power. Results fit the Large Helical Device (LHD) scaling and the drift wave turbulence scaling. Bootstrap currents observed during electron cyclotron heating agree with neoclassical theory in magnitude and parameter dependences. Fast reciprocating Langmuir probe measurements show that edge fluctuations in ATF have many similarities to those in the Texas Experimental Tokamak (TEXT). The location of $\tilde{B}$ instabilities has shifted outward in radius, consistent with the broader pressure profiles. 14 refs., 6 figs.

27312 (PPPL–2683) **The effect of plasma density on the behavior of the plasma boundary in helium discharges in the Tokamak Fusion Test Reactor.** Kilpatrick, S.J.; Pitcher, C.S.; Bell, M.G.; Manos, D.M.; Mansfield, D.K.; Nyberg, I.; Ramsey, A.T.; Stratton, B.C. Princeton Univ., NJ (USA). Plasma Physics Lab. Mar 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. (CONF-891093–27: 36. American Vacuum Society national vacuum symposium, Boston, MA (USA), 23-27 Oct 1989). Order Number DE90007942. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Langmuir probe measurements have been made across the plasma boundary in helium discharges of varying central electron densities in the Tokamak Fusion Test Reactor (TFTR). Radial profiles of ion saturation current density, I_s, electron density, n_e, and electron temperature, T_e, were achieved by small displacements of the plasma relative to a stationary probe. Scrape-off lengths outside the plasma boundary decreased somewhat with increasing plasma density. Inside the plasma, I_s, n_e, and T_e rose more steeply for the higher densities than the scrape-off lengths would predict. The floating potential, V_f, decreased sharply inside the boundary as expected, with some density dependence. I_s and n_e increased with plasma density, while T_e decreased a few eV. Measurements of C II emission at the inner wall combined with probe data support a relatively constant edge T_e with increasing plasma density and a constant ratio between the fluxes of helium and carbon ions. 14 refs., 5 figs.

27313 (PPPL–2684) **General guiding center drifts in TRANSP.** McCann, R.T. (John von Neumann National Supercomputer Center, Princeton, NJ (USA)); Goldston, R.J.; McCune, D.C. Princeton Univ., NJ (USA). Plasma Physics Lab. Feb 1990. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90007947. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This document describes the guiding center drift equations and some of the numerical techniques used in the Princeton Plasma Physics Laboratory's transport analysis code TRANSP which is used to evaluate the effect of neutral beam heating on various tokamak experiments at PPPL and elsewhere. The equations used are adapted from White and Boozer and are specialized to two dimensions by assuming perfect toroidal symmetry. The resulting minor cross section of the plasma is almost coplanar. Deviations from being coplanar are ignored. 6 refs.

27314 (PPPL–2687) **Characteristics of high-frequency precursors to edge-localized activity in the PBX-M tokamak.** Kaye, S.M. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Manickam, J.; Bell, R.; LeBlanc, B.; Kessel, C.; Kugel, H.; Paul, S.; Sesnic, S.; Takahashi, H.; Asakura, N. Princeton Univ., NJ (USA). Plasma Physics Lab. Mar 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90007946. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

High β_{pol} H-mode plasmas in the PBX-M tokamak often exhibit periods of Edge Localized Mode (ELM) activity, with each ELM preceded by a short duration ($\leq$ 350 μsec) burst of high frequency (200 to 250 kHz) magnetic activity. The burst grows on a time scale of 10 μsec, and disappears just prior to the rapid increase in the D_α emission that is characteristic of the ELM. The burst of activity is observed at all poloidal locations, with the largest amplitudes seen on the coils on the inner major radius side, indicating that the mode is not outward ballooning in character. Stability calculations indicate that a likely candidate for this high frequency ELM precursor is the pressure-driven ideal kink. 12 refs., 4 figs.

27315 (Rijnhuizen-report–89-186, pp. 1-9) **Measurements on waveguide components for ECRH on RTP.** Verhoeven, A.G.A. (Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica); Duit, H.; Mainintveld, P.; Polman, R.W.; Yidirim, A. NWO-Euratom-FOM Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Sep 1989. (CONF-8905159–: Joint IAEA technical committee meeting on ECE and ECRH and 7th joint workshop on ECE and ECRH (EC-7), Hefei (China), 8-11 May 1989). In *FOM-Rijnhuizen contributions to IAEA technical committee meeting on ECE and ECRH, seventh joint workshop on ECE and ECRH (EC-7), Hefei, P.R. China, 8-11 May 1989.* Order Number DE90618809. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

A design is presented of the transmission-line system for Electron Cyclotron Resonance Heating of the Rijnhuizen Tokamak Project (RTP). The rf power, produced by three 60 GHz, 200 kW

gyrotrons, will be conducted to the tokamak by means of overmoded waveguides. The power of the first gyrotron will be launched into the RTP plasma from the low magnetic field side in the equatorial plane. It will be radiated perpendicular to the plasma in the O-mode; the power that is not absorbed on the first pass is reflected on a mode-converting mirror. The power of the second and third gyrotron will be launched from the high field side (HFS) through top ports and will couple to the X-mode. Here the angles of incidence with respect to the plasma will be variable to obtain almost full single-pass absorption and heating of the selected flux surfaces. The required elliptical polarization for the top-launched waves will be obtained by means of a waveguide polarizer. This polarizer has a circular cross-section at both ends and a gradual squeeze in between. Measurements were made to analyse the efficiency and mode purity. The ends of the top launchers are curved HE_{11} waveguides. Antenna patterns for the launcher bends were measured. The efficiency and the mode content of several components of the waveguides were measured using a k-spectrometer. (author). 10 refs.; 9 figs.; 1 tab.

27316 (SAND–89-2064) **Thermal loads on tokamak plasma facing components during normal operation and disruptions.** McGrath, R.T. Sandia National Labs., Albuquerque, NM (USA). Jan 1990. 31p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90008033. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Power loadings experienced by tokamak plasma facing components during normal operation and during off-normal events are discussed. A model for power and particle flow in the tokamak boundary layer is presented and model predictions are compared to infrared measurements of component heating. The inclusion of the full three-dimensional geometry of the component and of the magnetic flux surface is very important in the modeling. Experimental measurements show that misalignment of component armor tile surfaces by only a millimeter can lead to significant localized heating. An application to the design of plasma facing components for future machines is presented. Finally, thermal loads expected during tokamak disruptions are discussed. The primary problems are surface melting and vaporization due to localized intense heating during the disruption thermal quench and volumetric heating of the component armor and structure due to localized impact of runaway electrons. 44 refs., 9 figs., 2 tabs.

27317 (UCRL-ID–103119) **An extended diffusive model for calculating thermal diffusivity from single monopole tokamak heat pulse propagation.** Marinak, M. (California Univ., Berkeley, CA (USA)). Lawrence Livermore National Lab., CA (USA). Feb 1990. 31p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. Order Number DE90007958. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The problem of deducing χ_e from measurements of the propagation of a monopole heatpulse is considered. An extended diffusive model, which takes into account perturbed sources and sinks is extended to the case of a monopole heat input. χ_e is expressed as a function of two observables, the heat pulse velocity and the radial damping rate. Two simple expressions valid for two different ranges of the radius of the poloidal waist of the beam power profile are given. The expressions are valid in the heat pulse measurement region, extending radially 0.05a beyond the beam power waist to near 0.6a. The inferred χ_e is a local value, not an average value of the radial χ_e profile. 7 refs., 6 figs., 1 tab.

27318 **Trapped-particle instability and flute instability in Tandem mirror; scale separation closure in Alfven-wave turbulence.** Chen, C. Thesis (Ph. D.). 168p. Univ. of Texas, Austin, TX (US) (1988). Available from University Microfilms, PO Box 1764, Ann Arbor, MI 48106, Order No.89-01,290.

Two different topics are discussed: instability in Tandem mirrors and closure schemes in turbulence theories. In the tandem mirror study, an appropriate quadratic functional form is constructed taking into account equilibrium rotational effects, electron temperature gradients, ion Landau damping, and electron-collisional effects. The collisional effects, which are described by the Fokker-Planck equation, are evaluated by using the solution for the particle and energy lifetime of an electron in an ambipolar trap and a magnetic trap. With the quadratic form, a dispersion relation that covers both the trapped-particle modes and the flute modes is derived and discussed. The numerical studies utilizing parameters suitable to the TMX-U mirror (Livermore) are conducted. The second topic is to study the renormalized turbulence theory. After analyzing the process of the wave-wave incoherent interaction, it is argued that the incoherent source term for most turbulence systems lacks fine structure in the k-w space. Based on the concept of scale separation between the coherent response function and the incoherent source, a closure scheme for the renormalized turbulence equation is proposed. A model dealing with the shear-Alfven wave turbulence is numerically solved.

27319 **Wave coupling and matching of waveguide couplers in the ion-cyclotron range of frequencies.** Lee, J.L. Thesis (Ph. D.). 256p. Univ. of Wisconsin, Madison, WI (US) (1988). Available from University Microfilms, PO Box 1764, Ann Arbor, MI 48106, Order No.88-26,054.

Theoretical analyses and experimental measurements were performed to study waveguide couplers in the ion cyclotron range of frequencies (ICRF, 50-300 MHz) for plasma-heating applications. For the compact dielectric-filled rectangular waveguide coupler, the input impedances and the input reflection coefficients were derived for both the open-ended and the shorted probes, with the coupler output being matched or loaded. Numerical analysis showed that a shorted probe offers a better coupling efficiency than an open-ended probe when the waveguide is filled with a high-permittivity dielectric and under high-power operation. The model for the phase shift agreed very well with the measured results. In general, close agreement was obtained between measurements and the analytical models for the input reflection coefficient for the matched and the plasma-loaded waveguide couplers. A vacuum-folded waveguide coupler was analyzed and preliminary measurements were made on it. Guidelines are discussed for when waveguide couplers might be superior to coils for tokamak plasma-heating experiments. Waveguide couplers could be superior for the reactor ICRF range above 60 MHz where a power flux higher than 2 kW/cm^2 is desired.

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Refer also to citation(s) 26441, 26453, 27272, 27281, 27286, 27289, 27358

27320 (CONF-9003122–1) **Simple light gas guns for hypervelocity studies.** Combs, S.K.; Haselton, H.H.; Milora, S.L. Oak Ridge National Lab., TN (USA). [1990]. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Special operations Expo '90; Idaho Falls, ID (USA); 20-22 Mar 1990. Order Number DE90008907. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Two-stage light guns are used extensively in hypervelocity research. The applications of this technology include impact studies and special materials development. Oak Ridge National Laboratory (ORNL) has developed two-stage guns that accelerate small projectiles (4-mm nominal diameter) to velocities of up to ≈5 km/s. These guns are relatively small and simple (thus, easy to operate), allowing a significant number of test shots to be carried out and data accumulated in a short time. Materials that have been used for projectiles include plastics, frozen isotopes of hydrogen, and lithium hydride. One gun has been used to demonstrate repetitive operation at a rate of 0.7 Hz; and, with a few design improvements, it appears capable of performing at firing frequencies of 1–2 Hz. A schematic of ORNL two-stage device is shown below. Unlike most such devices, no rupture disks are used. Instead, a fast valve (high-flow type) initiates the acceleration process in the first stage. Projectiles can be loaded into the gun breech via the slide mechanism; this action has been automated which allows repetitive firing. Alternatively, the device is equipped with "pipe gun" apparatus in which gas can be frozen in situ in the gun barrel to form the projectile. This equipment operates with high reliability and is well suited for small-scale testing at high velocity. 17 refs., 6 figs., 2 tabs.

27321 (DOE/DP/40200–112) **LLE review: Quarterly report, October–December 1989: Volume 41.** Bradley, D.K. (ed.). Rochester Univ., NY (USA). Lab. for Laser Energetics. [1989]. 67p.

Sponsored by U.S. DOE Defense Programs. DOE Contract FC03-85DP40200. Order Number DE90008958. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This volume of the LLE Review, covering the period October–December 1989, contains an article discussing saturation effects and power-balance considerations in the design of high-power lasers and an article describing numerical modeling of the effects of power imbalances on target benavior. The advanced technology section reports on the development of a liquid crystal laser-beam apodizer and an experiment to study the high-intensity ionization of noble gases. Finally, the activities of the National Laser Users Facility and the GDL and OMEGA laser facilities are summarized. The highlights of this issue are: The problem of achieving power balance in high-efficiency, multibeam lasers has been studied in terms of gain-saturation effects and the nonlinear nature of harmonic frequency conversion. It is shown that power imbalance can be minimized by balancing the gains and losses in equivalent amplification stages in each beamline. The effects of target implosion behavior of various power-imbalance sources in the OMEGA laser system have been studied using the two-dimensional hydrodynamics code ORCHID. The simulations show good agreement with an experiment in which a deliberate power imbalance was applied to the target drive. Laser-beam apodizers with large clear apertures have been fabricated using cholesteric liquid crystals. A soft-edge profile has been achieved by filling a cell with two separate liquid crystals with different selective-reflection bands, and allowing them to partially mix at the interface. A study of the ionization of noble gases in the tunneling regime using high- intensity, 1-ps pulses from the tabletop terawatt laser (T^3) has been carried out. The measured ion production is well predicted by a Coulomb barrier suppression ionization theory.

27322 (DOE/ET/51013–T225) **Safety and protection for large-scale magnet systems: FY89 report.** Thome, R.J.; Oshima, M.; Pillsbury, R.D. Jr.; Mann, W.R. Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center. Mar 1990. 34p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-78ET51013. (PFC/RR–89-18). Order Number DE90009308. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the following topics: computation of quench propagation in multiple superconducting coils, and torsional shear development in central solenoids.

27323 (ENEA-RT-FUS–88-19) **Contribution to the 19th ECLIM – European conference on laser interaction with matter (Madrid, 3–7 Oct 1988).** ENEA, Frascati (Italy). Dipt. Fusione. Apr 1989. 42p. (CONF-881056–Exc.: 19. European conference on laser interaction with matter (ECLIM), Madrid (Spain), 3-7 Oct 1988). Order Number DE90706077. Available from NTIS (US Sales Only), PC A03/MF A01.

Individual papers are indexed separately.

27324 (ENEA-RT-FUS–88-19, pp. 35-38) **Arbitrary Langrangian-Eulerian laser fusion code and its implementation on a vector multi-processor supercomputer.** Atzeni, S. (Associazione Euratom-ENEA sulla Fusione, Frascati (Italy)). ENEA, Frascati (Italy). Dipt. Fusione. Apr 1989. (CONF-881056–Exc.: 19. European conference on laser interaction with matter (ECLIM), Madrid (Spain), 3-7 Oct 1988). In *Contribution to the 19th ECLIM - European conference on laser interaction with matter (Madrid, 3-7 Oct 1988).* Order Number DE90706077. Available from NTIS (US Sales Only), PC A03/MF A01.

The parallel implementation of the laser fusion code DUED on the IBM 3090-400 VF vector multiprocessor, by means of the IBM Parallel Fortran is described. Parallel performance are reported for both the separate code modules and for typical runs on the whole code. An attempt to transform the purely Langrangian scheme of DUED into an arbitrary Langrangian-Eulerian scheme is also discussed.

27325 (ENEA-RT-FUS–88-19, pp. 5-33) **2-D studies of non-uniformly irradiated spherical shells.** Atzeni, S. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)). ENEA, Frascati (Italy). Dipt. Fusione. Apr 1989. (CONF-881056–Exc.: 19. European conference on laser interaction with matter (ECLIM), Madrid (Spain), 3-7 Oct 1988). In *Contributions to the 19th ECLIM - European conference on laser interaction with matter (Madrid, 3-7 Oct 1988).* Order Number DE90706077. Available from NTIS (US Sales Only), PC A03/MF A01.

The effect of long scale-length irradiation non-uniformities on the implosion of directly driven, gas filled shells is studied by means of 2-D numerical fluid simulations. Quantitative results are given on the shell deformation as a function of the wavelength and amplitude of the irradiation non-uniformity. The reflection of the imploding schock-wave is also qualitatively illustrated.

27326 (ENEA-RT-FUS–89-01, pp. 5-8) **Analytical field results for low aspect ratio stellarator configurations.** Alladio, F. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)); Crisanti, F.; De Marco, F.; Mancuso, S. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

This report describes the development of a model for a machine oriented vacuum configuration designed to be as similar as possible to an idealized surface current stellarator configuration with poloidal (m) and toroidal winding (n) numbers equal to 2 and 6 respectively (aspect ratio, A=2.7 at magnetic scalar potentials of 0, minus 2PI/4n and minus 2PI/2n). Its main features are modules of total current, I=8.33 MA for each of the two helical coils and return currents, I_{v1}=minus 2.37 MA for the inner vertical coils and I_{v2}=minus 4.49 MA for outer coils. The main difference is that the volume of the configuration becomes even larger (lambda=2.3) keeping the same value of rotational transform at the edge, but the sharp separatrix-like features of the more idealized configuration are lost. The obvious advantages of a compact torsatron configuration are briefly: the lower cost of small aspect ratio machines and the high equilibrium and stability beta limit. Two main troublesome points, the alpha-particle confinement capabilities of such configuarations and their resilience to flux surface breaking due to field errors and beta effect, are presently under investigation.

27327 (ENEA-RT-FUS–89-01, pp. 21-24) **2-D simulation of the implosion, collapse and stagnation of laser fusion shells.** Atzeni, S. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)); Guerrieri, A. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European Conference on controlled fusion and plasma physics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

The method, model and first results of 2-D numerical simulations of the entire history of D-T gas filled, thin glass shells irradiated by laser pulses with long wavelength non-uniformities are discussed. Although this issue has already been addressed in connection with the design of reactor targets, or with the interpretation of experimental results, a complete, clear, and quantitative picture of the relevant phenomenology is still missing. In general, the history of a target can be divided into three phases, namely, acceleration and intertial phase of the implosion, shock collapse and reflection, and stagnation. In a previous study, it was possible to quantitatively study phase 1 and to get some qualitative information on phase 2. At t approximately equal to t_o, however, negative area zones occurred in the mesh of our purely Langrangian code, and the simulations became unreliable. The code has now been upgrade by the introduction of an automatic mesh-rezoning package, which allows phases 2 and 3 of the target implosion to be followed with reasonable accuracy.

27328 (ENEA-RT-FUS–89-01, pp. 45-48) **Tokamak configuration analysis with the method of toroidal multipoles.** Micozzi, P. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)); Alladio, F.; Crisanti, F.; Marinucci, M.; Tanga, A. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13-17*

Mar 1989). Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

In the study of tokamak machines able to sustain plasmas of thermonuclear interest (JET, IGNITOR,NET, CIT, ET), there is a strong quest for the engineering optimization of the circuital components close to the plasma. A semi-analytical axisymmetric MHD equilibrium code, based on the technique of the poloidal flux function expansion in toroidal harmonic series, is presented. This code is able to optimize the necessary currents in the poloidal circuits in order to sustain a plasma of fixed shape (also x-point configuration), toroidal current and poloidal beta. This code can work prescribing both a free, as well as a fixed boundary: in both cases the analyst must give the total plasma current, the poloidal beta and the functional forms of plasma pressure and poloidal plasma current. Moreover, in the free boundary case, the analyst must provide the poloidal currents external to the integration domain: on the other hand, in the fixed boundary case, instead of providing these currents, the analyst must choose the contour of the last plasma magnetic surface as a set of points in which toroidal current density equals zero.

27329 (ENEA-RT-FUS–89-01, pp. 61-64) **Erosion-redeposition processes on the FT limiter studied by tests on different material.** Maddaluno, G.; Martinelli, A.P. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

Long-term targets of different material (graphite and titanium) were used on the FT limiter to get information about the erosion and deposition processes. From impurity concentration and weight change measurements, graphite targets were found to be more eroded than titanium ones beyond 1 cm from the plasma edge, probably as a result of the different sputtering yield. A poloidally and directionally asymmetric pattern of the metal deposit was found too; a pattern depends on the toroidal magnetic field direction. The low erosion of medium-z material on the limiter support could mean a tolerable metal contamination of the graphite mushrooms in the metal-graphite limiter envisaged for the FT tokamak.

27330 (ENEA-RT-FUS–89-01, pp. 69-72) **FTU pump limiter.** Alessandrini, C. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)); Ciotti, M.; De Matteis, A.; Maddaluno, G.; Mazzitelli, G. ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European on controlled fusion and plasma physics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

This paper reports the details of the design and analysis of the pump limiter which is to be incorporated in the Frascati Tokamak Upgrade (FTU). The FTU, presently under commissioning, is a compact, high field (B=8 T), medium high density, circular cross section machine with small accesses. The dimensions of the equatorial port (width 8 cm) would reduce the length of the entrance throat to a few centimeters, which is unacceptable for efficient particle trapping. Therefore, a rotating blade of the pump limiter head was designed in such a way that the blade, in the working position, extends into the toroidal direction inside the vacuum chamber. Bulk getter pumps will be employed to exhaust the particles trapped in the limiter throat. A simple model of the scrape-off layer (SOL) was adopted for the analysis and design of the pump limiter which will be installed at the beginning of 1990 in the high density, high field machine. Experimental work will be principally devoted to the control of the plasma density in ohmic discharges and to the study of plasma edge related phenomena.

27331 (ENEA-RT-FUS–89-01, pp. 81-84) **High field tokamaks: The why's and how's.** Sestero, A. (Associazione EURATOM-ENEA sulla Fusione, Frascati (Italy)). ENEA, Frascati (Italy). Dipt. Fusione. Feb 1989. (CONF-890302–Exc.: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *Contributions to the 16th European conference on controlled fusion and plasma physics (Venice, 13-17 Mar 1989).* Order Number DE90706075. Available from NTIS (US Sales Only), PC A05/MF A01.

Factors usually considered in the developement of scaling laws for high field tokamaks, i.e. Lawson parameter, temperature, ion mass, etc., are discussed and it is shown how, by the selection of mangetic energy content as an extensive variable, cost supposedly depends on the discharge parameter, magnetic field - aspect ratio -safety factor - plasma. With regard to full exploitation of advantages from high fields by the use of innovative toroidal magnet engineering, two concepts are examined: an active mechanical support scheme implemented by way of a press and an equally promising alternative which involves the tilting, in the most critically loaded throat region, of the turns of the toroidal magnet by a suitable amount with respect to the meridian plane.

27332 (ENEA-RTI-TIB–89-30) **ENEA lithium aluminate breeder target for exotic-5.** Alvani, C.; Casadio, S.; Mancini, M.R.; Pierdominici, F. ENEA, Casaccia (Italy). Dipt. Tecnologie Intersettoriali di Base. 1989. 16p. (RTI/TIB–89-30). Order Number DE90764325. Available from NTIS (US Sales Only), PC A03/MF A01.

The fabrication route and characteristics are reported for LiAlO2 breeding pellets prepared for an EXOTIC-5 irradiation test conducted within the framework of the European program on fusion technology. In order to get sub-micronic near pure gamma-LiAlO2 powder without any grinding step, DEGUSSA C-type gamma aluminia was used as a precursor in the synthesis route. The preparation flowsheet was the following: calcination of aluminia precursor (water elimination); mixing aluminia+peroxide (in dry ethyl alcohol); drying the mixture (mixing+drying simultaneously in a ROTAVAPOR); deagglomeration and calcination (one hour at 800 C). By carefully avoiding exceeding the atomic lithium versus aluminium content in the precursor mixture (Li was slightly less than the stoichiometric required 1:1 against Al), a fine white powder was obtained with very good sintering properties. Cold pressing of EXITIC-5 speciments was performed at 1 tonne/square centimeter and sintering temperature was 1100 C. The ENEA (Italian Commission for Alternative Energy Soruces) EXOTIC-5 specimen characteristics has a specific surface area of 2.35 square meters/gm true density of 2.60 g/cubic centimeterm mean pore size of 0.17 microns and a Li=6 isot. content of 7.6%.

27333 (GA-A–19923) **Applied Plasma Physics annual report, October 1, 1988–September 30, 1989.** General Atomics, San Diego, CA (USA). Feb 1990. 61p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-89ER53277. Order Number DE90007932. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This report discusses the following topics on controlled magnetic fusion: applied plasma physics overview; fusion plasma theory; fusion user service center; diagnostics; and ergodic and resonant magnetic divertor experiments on text.

27334 (GA-A–19924) **Fusion technology development annual report, October 1, 1988–September 30, 1989.** General Atomics, San Diego, CA (USA). Feb 1990. 27p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-89ER52153. Order Number DE90007933. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report discusses the following topics on magnetic fusion: RF technologies; plasma facing components; reactor design studies; fusion nuclear technologies; and fusion materials development.

27335 (HEDL-SA–3676) **First wall/blanket/magnet activation: Status and implications.** Mann, F.M.; Doran, D.G. Hanford Engineering Development Lab., Richland, WA (USA). Mar 1987. 23p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76FF02170. (CONF-870410–42: 193. national meeting of the American Chemical Society, Denver, CO (USA), 5-10 Apr 1987). Order Number DE90009137. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Unlike fission reactors, fusion reactors can be designed as to reduce significantly the problems of radioactive waste disposal. As part of the fusion materials program, we are investigating the implications of the choice of materials, of the potential variations in the

composition of those materials, and, to some extent, of reactor design on waste disposal and the alternative, recycling. This paper includes recent calculations on first wall, blanket, magnet, and magnet structure materials as well as a discussion of their implications. The tools and assumptions that are used in these analyses will be described. 15 refs., 4 tabs.

27336 (LRP–368/89) **Effect of power reflection on the operation of a low Q 8 GHz gyrotron.** Muggli, P. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Tran, M.Q.; Tran, T.M.; Alberti, S.; Perrenoud, A.; Mathews, H.G.; Agosti, G. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1989. 24p. Order Number DE90620732. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The operating characteristics of a low Q (Q_{cav}=225), 8 GHz gyrotron oscillator operating in TE^{o}_{011} mode and submitted to various mismatched loads are reported. Under matched conditions, output power up to 310 kW (η=35%) and maximum efficiency up to 43% have been measured. In general, power reflection from loads with different phase and amplitude leads to an output power decrease. Too high reflections cause mode switching (TE^{o}_{111} to TE^{0}_{012}) or even arcing inside the tube. The effect of power reflection is seen to increase rapidly with current and output power. Nevertheless, we have observed that, as predicted by the calculations, the maximum output power is not reached under matched conditions but with a specific value of the complex reflection coefficient. (author) 6 figs., 2 tabs., 13 refs.

27337 (PNL-SA–16987) **Neutron-Induced Swelling of Model Fe-Cr-Mn-Ni Alloys and Commercial Manganese-Stabilized Steels.** Garner, F.A. (Pacific Northwest Lab., Richland, WA (USA)); Brager, H.R.; Takahashi, H. Pacific Northwest Lab., Richland, WA (USA). [1989]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. (CONF-891204–29: 4. international conference on fusion reactor materials, Kyoto (Japan), 4-8 Dec 1989). Order Number DE90009173. Available from NTIS, PC A03/MF A01; OSTI; INIS.

The addition of nickel to both simple and solute-modified Fe-Cr-Mn alloys leads initially to an increase in neutron-induced swelling. The addition of various minor solutes, particularly silicon, in general leads to a reduction in swelling. Depending on composition, thermomechanical condition and irradiation temperature, a wide variety of swelling behavior is observed in various commercial Fe-Cr-Mn alloys. There is some indication in the commercial alloys of massive formation of ferrite phases during irradiation at 420°C, leading to a reduction in the swelling rate. 6 refs., 6 figs., 2 tabs.

27338 (PNL-SA–16988) **Isotopic tailoring with ^{59}Ni to study the influence of helium/dpa ratio on tensile property changes.** Garner, F.A. (Pacific Northwest Lab., Richland, WA (USA)); Hamilton, M.L.; Simons, R.L.; Maxon, M.K. Pacific Northwest Lab., Richland, WA (USA). [1989]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. (CONF-891204–28: 4. international conference on fusion reactor materials, Kyoto (Japan), 4-8 Dec 1989). Order Number DE90009180. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Irradiation of miniature tensile specimens of simple model Fe–Cr–Ni alloys is proceeding in the Fast Flux Test Facility to study the interactive effects of alloy composition, cold work level, helium/dpa ratio and irradiation temperature on the evolution of microstructure and associated changes in mechanical properties. The addition of ^{59}Ni to these alloys allows side-by-side irradiation of otherwise identical specimens, differing only in helium/dpa ratio. In the absence of differences in displacement rate and temperature history, it is shown that helium in this experiment exerts a rather small influence on tensile properties at 365 and 600°C. While the saturation level of yield stress in Fe–25Ni–15Cr is strongly dependent on irradiation temperature, it is relatively insensitive to cold work level and helium/dpa ratio. At 365°C, the yield strength of Fe–25Ni–15Cr is increased slightly by addition of 0.04 wt % phosphorus. 18 refs., 4 figs.

27339 (PNL-SA–17161) **Swelling of neutron-irradiated vanadium alloys.** Loomis, B.A. (Argonne National Lab., IL (USA). Materials and Components Technology Div.); Smith, D.L.; Garner, F.A. Pacific Northwest Lab., Richland, WA (USA). Dec 1989. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. (CONF-891204–27: 4. international conference on fusion reactor materials, Kyoto (Japan), 4-8 Dec 1989). Order Number DE90009172. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The swelling of unalloyed vanadium and vanadium alloys containing Cr, Ti, Si, Fe, Zr, W, Mo, and Ni additions was determined after neutron irradiation at 420 and 600°C to 17–84 dpa in the FFTF-MOTA reactor facility. The swelling of these materials was obtained from a determination of the immersion density of the unirradiated and irradiated materials. The swelling of V is substantially increased by the addition of Cr, and significantly reduced by the addition of Ti. The swelling of V–Cr–Ti alloys is strongly dependent on Ti concentration for Ti concentrations <3%. For resistance to irradiation-induced swelling, the Ti concentration in a V–Cr–Ti alloy that is to be used as a structural material in a magnetic fusion reactor should be greater than 3%. For these ranges of Ti concentration in a V–Cr–Ti alloy, Cr concentrations of <15% have minimal effect on the swelling of the alloy. The Vanstar-7 alloy exhibits high (7–10%) swelling on irradiation at 600°C to 77 dpa. Swelling of V-7.2Cr-14.5Ti, V-13.5Cr-5.2Ti, V-9.2Cr-4.9Ti, V-3. 1Ti-(0.3–0.5)Si, and V-17.7Ti on neutron irradiation at 600°C to 87 dpa is (in % per dpa) 0.10, 0.03, 0.03, 0.01, and 0.01, respectively. 14 refs., 3 figs., 1 tab.

27340 (SAND–89-1483C) **Electron beam energy deposition and transport in transverse geometry.** Patterson, E.L.; Samlin, G.E. Sandia National Labs., Albuquerque, NM (USA). [1989]. 47p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-8906200–5: Large area electron beam diode workshop, Monterey, CA (USA), 7 Jun 1989). Order Number DE90009352. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Results of measurements and calculations are presented for a spatially rectangular electron beam propagation in a direction perpendicular to the axis through a cylindrical laser cell filled with either nitrogen at pressures up to 5 atm or SF_6 at pressures up to 4 atm. For nitrogen pressures up to 5 atm the electron beam traversed the 25-cm diameter laser chamber without significant spreading. The measured current neutralization was about 90% for SF_6 pressures up to 2 atm. At SF_6 pressures greater than 3 atm the electrons experience severe scattering and most of the energy reached the cell wall at locations with angles larger than 90° with respect to the original beam direction. The most uniform electron-beam energy deposition was observed at an SF_6 pressure of 3 atm where 44% of the beam energy was deposited in the gas. Photographic observations of a 30 cm × 100 cm rectangular beam propagating in atmospheric air are also presented. These observations illustrate the effect of an applied axial magnetic field on electron-beam uniformity and rotation. Observations lead to suggestions for improving electron-beam transport efficiency and uniformity.

27341 **Overview of inertial fusion program.** Jones, R.A. (Department of Energy, Washington, DC (USA)). pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 6. IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989). Paper 899507.

The inertial fusion program is discussed in this paper. It is a special part of the Weapons Research, Development, and Testing technology base. In the near term, the program contributes to the nuclear weapons program through increased understanding of the phenomena that occur during a thermonuclear explosion; in the future, there is the potential of a civilian energy application to electric power generation.

27342 **World progress toward fusion energy.** Davies, N.A. (Office of Fusion Energy, Office of Energy Research (US)). pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 6. IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 893506.

The author discusses international progress in fusion research during the last three years. Much of the technical progress has been achieved through international collaboration in magnetic fusion research. This progress has stimulated political interest in a multinational effort, aimed at designing and possibly constructing the world's first experimental fusion reactor. This interest was reflected in recent summit-level discussions involving President Mitterand, General Secretary Gorbachev, and President Reagan. Most recently, the European Community (EC), Japan, the United States, and the U.S.S.R. have decided to begin serious preparation for taking the next step toward practical fusion energy. These parties have agreed to begin the design and supporting R and D for an International Thermonuclear Experimental Reactor (ITER) under the auspices of the International Atomic Energy Agency (IAEA). The initiation of this international program to prepare for a fusion test reactor is discussed.

99 GENERAL AND MISCELLANEOUS

Refer also to citation(s) 27372

9901 Management

Refer also to citation(s) 25542, 25605, 25808, 25885, 26549

27343 (CEA-LETI-RA–1987) **The progress report of the instrumentation and Technological Electronical Division, for 1987.** CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI). May 1988. 165p. (In French). Order Number DE90770261. Available from NTIS (US Sales Only), PC A08/MF A01.

The 1987 activity report of the CEA Instrumentation and Technological Electronic Division (ITED), is presented. The ITED fields of interest include nuclear, space, health, defense and civil domains. The research development and perspectives are summarized. Concerning materials and components the following research programs are included: silicon integrated circuits, silicon on isolator, common experimental laboratory, mass memory, lasers, photodetection, flat screens, and sensors. In the field of instrumentations and systems, the retained research guidelines are focused on: medical and biological instrumentation, the environment, the nuclear domain. Moreover, the research fields of physics, artificial intelligence and software, production, robots, architecture and integration are also included.

27344 (OUP–89-11) **How the schools can participate in measuring radon, thoron and radioactive fallout.** Storruste, A.; Larsen, E. Oslo Univ. (Norway). Fysisk Inst. Dec 1989. 35p. Order Number DE90623352. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The Chernobyl accident revealed that people in general have very little knowledge about radioactivity. The general knowledge should be improved rather cheaply and with small efforts through the introduction of a few experiments into the school curriculum. In the report some simple experiments of this kind are described. All the main apparatus needed are an ordinary GM counter and a vacuum cleaner. By using the same method at many schools, the data from the measurement of natural radioactivity variations in the air throughout the year could be usefully collected and collated. This would make the experiments more interesting than an experiments having no other purpose than the learning process itself. 12 refs.; 5 figs.

27345 (OUP–89-22) **List of publications 1988: Scientific and specialist works from Department of Physics.** Oslo Univ. (Norway). Fysisk Inst. Oct 1989. 63p. (In Norwegian). Order Number DE90623353. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This annual bibliography of publications refers to research reports, contribution to newspapers and scientific journals, guest lectures and popular science lectures.

9902 Mathematics and Computers

Refer also to citation(s) 25578, 25585, 25586, 25590, 25614, 25683, 25789, 25790, 25799, 25820, 25826, 25827, 25830, 25835, 25922, 25941, 25942, 26004, 26005, 26007, 26008, 26009, 26021, 26023, 26131, 26211, 26251, 26254, 26260, 26336, 26385, 26415, 26445, 26495, 26503, 26514, 26543, 26547, 26548, 26550, 26553, 26564, 26763, 26775, 26779, 26788, 26840, 27047, 27054, 27205, 27324, 27328, 27383

27346 (AD-A–215762/6/XAB) **Hypercube expert system shell-applying production parallelism. Master's thesis.** Harding, W.A. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Dec 1989. 134p. (AFIT/GCS/ENG–89D-6). Available from NTIS, PC A07/MF A01.

This research investigation proposes a hypercube design which supports efficient symbolic computing to permit real-time control of an air vehicle by an expert system. Design efforts are aimed at alleviating common expert system bottlenecks, such as the inefficiency of symbolic programming languages like Lisp and the disproportionate amount of computation time commonly spent in the match phase of the expert system match-select-act cycle. Faster processing of Robotic Air Vehicle (RAV) expert system software is approached through (1) fast production matching using the state-saving Rete match algorithm, (2) efficient shell implementation using the C-Programming Language and (3) parallel processing of the RAV using multiple copies of a serial expert system shell. In this investigation, the serial C-Language Integrated Production System shell is modified to execute in parallel on the iPSC/2 Hypercube. Speedups achieved using this architecture are quantified through theoretical timing analysis, and comparison with serial architecture performance results, with earlier designs performance results, with best case results and with goal performance.

27347 (AD-A–215805/3/XAB) **Parallel solution of the symmetric tridiagonal eigenproblem. Research report.** Jessup, E.R. Yale Univ., New Haven, CT (USA). Dept. of Computer Science. Oct 1989. 81p. (YALEU/DCS/RR–728). Available from NTIS, PC A05/MF A01.

This thesis discusses methods for computing all eigenvalues and eigenvectors of a symmetric tridiagonal matrix on a distributed-memory Multiple Instruction, Multiple Data multiprocessor. Only those techniques having the potential for both high numerical accuracy and significant large-grained parallelism are investigated. These include the QL method or Cuppen's divide and conquer method based on rank-one updating to compute both eigenvalues and eigenvectors, bisection to determine eigenvalues and inverse iteration to compute eigenvectors. To begin, the methods are compared with respect to computation time, communication time, parallel speed up, and accuracy. Experiments on an IPSC hypercube multiprocessor reveal that Cuppen's method is the most accurate approach, but bisection with inverse iteration is the fastest and most parallel. Because the accuracy of the latter combination is determined by the quality of the computed eigenvectors, the factors influencing the accuracy of inverse iteration are examined. This includes, in part, statistical analysis of the effect of a starting vector with random components. These results are used to develop an implementation of inverse iteration producing eigenvectors with lower residual error and better orthogonality than those generated by the EISPACK routine TiNVIT. This thesis concludes with adaptions of methods for the symmetric tridiagonal eigenproblem to the related problem of computing the singular value decomposition (SVD) of a bidiagonal matrix.

27348 (AD-A–215806/1/XAB) **Domain decomposition with local mesh refinement. Research report.** Gropp, W.D.; Keyes, D.E. Yale Univ., New Haven, CT (USA). Dept. of Computer Science. Aug 1989. 30p. (YALEU/DCS/RR–726). Available from NTIS, PC A03/MF A01.

A preconditioned Krylov iterative algorithm is based on domain decomposition for implicit linear systems arising from partial differential equation problems which require local mesh refinement. To keep data structures as simple as possible for parallel computing applications, the fundamental computational unit in the algorithm is a subregion of the domain spanned by a locally uniform tensor-product grid, called a tile. This is in contrast to local refinement

techniques whose fundamental computational unit is a grid at a given level of refinement. Bookkeeping requirements of grid algorithms are potentially substantial, since consistency of data must be enforced at points of space which may belong to several different grids and the grids are not necessarily of tensor-product type, but more generally, unions thereof. The tile-based domain decomposition approach condenses the number of levels in consideration at each point of the domain to two: a global coarse grid defined by tile vertices only and a local fine grid, where the degree of resolution of the fine grid can vary from tile to tile. Experimentally, it is shown that one global level and one local level provide sufficient flexibility to handle a diverse collection of problems which include irregular regions, non-simply connected regions, non-self adjoint operators, mixed boundary conditions, non-smooth coefficients, or non-smooth solutions. Tiles on problems containing up to 16K degrees of freedom.

27349 (AD-A–215870/7/XAB) **Technology development and circuit design for a parallel laser programmable floating-point application specific processor. Master's thesis.** Scriber, M.W. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Dec 1989. 123p. (AFIT/GCE/ENG–89D-6). Available from NTIS, PC A06/MF A01.

The laser programmable floating point application specific processor (LPASP) is a new approach at rapid development of custom VLSI chips. The LPASP is a generic application specific processor that can be programmed to perform a specific function. The effort of this thesis is to develop and test the double precision floating point adder and the laser programmable read-only memory (LPROM) that are macrocells within the LPASP. In addition, the thesis analyzes the applicability of an LPASP parallel processing system. The double precision floating point adder is an adder/subtractor macrocell designed to comply with the IEEE double precision floating point standard. An 84-pin chip of the adder was fabricated using 2 micron feature sizes. The fastest processing time was measured at 120 nanoseconds over 23 worst case test vectors. The adder uses the optimized carry multiplexed (OCM) adder that was developed at AFIT. The OCM adder is a new adder architecture that uses four parallel carry paths to attain a performance time on the order of (cubed root of M) with a gate count on the order of O (n). The redundant logic associated with the parallel propagation banks is eliminated in the OCM adder so that the largest bit-slice of the adder contains only eight 2-to-1 multiplexer gates. A 57-bit adder was fabricated using 2 micron feature sizes. The processing time for the adder is 31 nsec.

27350 (AD-A–216302/0/XAB) **Parallel memory addressing using coincident optical pulses. Final report, 15 July 1988-14 July 1989.** Chiarulli, D.M.; Melhem, R.G.; Levitan, S.P. Pittsburgh Univ., PA (USA). 15 Sep 1989. 86p. Available from NTIS, PC A05/MF A01.

This research was a preliminary investigation of the applicability of coincident optical pulse techniques to hybrid electronic-optical computing systems. The results of the investigation are focused in two areas. First, it was determined that the technological constraints for pulse generation, detection, and synchronization do not substantially restrict the applicability of the technique. This conclusion was based on the results of pulse coincidence experiments. Second, the application of the technique is not restricted to memory addressing structures as had been originally proposed. It was demonstrated that coincident pulse methods can be applied to general multiprocessor interconnections. In this context they can be used to provide the functionality and performance of fully interconnected systems while using low cost and low complexity optical structures.

27351 (AD-A–216407/7/XAB) **Theoretical and experimental analyses of parallel combinatorial algorithms. Doctoral thesis.** Phillips, C.A. Massachusetts Inst. of Tech., Cambridge, MA (USA). Lab. for Computer Science. Oct 1989. 157p. (MIT/LCS/TR–462). Available from NTIS, PC A08/MF A01.

This thesis investigates parallel algorithms for a small, but representative, subclass of graph and matrix problems. In some cases, we develop new algorithms which we analyze for theoretical efficiency. In other cases, we modify and implement existing algorithms which we analyze for practical efficiency. We show how n-node, e-edge graphs can be contracted in a manner similar to the parallel tree contraction algorithm due to Miller and Reif. We give an O((n+e)/lg n)-processor deterministic algorithm that contracts a graph in O(lg squared n) time in the EREW PRAM model.

27352 (ANL–90/9) **OTTER [Organized Techniques for Theorem-proving and Effective Research] 2.0 users guide.** McCune, W.W. Argonne National Lab., IL (USA). Mar 1990. 31p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90007978. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

OTTER (Organized Techniques for Theorem-proving and Effective Research) is a resolution-style theorem-proving program for first- order logic with equality. OTTER includes the inference rules binary resolution, hyperresolution, UR-resolution, and binary paramodulation. Some of its other abilities are conversion from first-order formulas to clauses, forward and back subsumption, factoring, weighting, answer literals, term ordering, forward and back demodulation, evaluable functions and predicates, and Knuth-Bendix completion. OTTER is coded in C, it is free, and it is portable to many different kinds of company. 16 refs., 2 tabs.

27353 (ANL–90/12) **Activities and operations of the Advanced Computing Research Facility, January 1989–January 1990.** Pieper, G.W. Argonne National Lab., IL (USA). Feb 1990. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90007957. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report reviews the activities and operations of the Advanced Computing Research Facility (ACRF) for the period January 1, 1989, through January 31, 1990. The ACRF is operated by the Mathematics and Computer Science Division at Argonne National Laboratory. The facility's principal objective is to foster research in parallel computing. Toward this objective, the ACRF continues to operate experimental advanced computers and to sponsor new technology transfer efforts and new research projects. 4 refs., 8 figs.

27354 (CIEMAT–625) **REGISTRO: informatic application for a general file management.** Botija, L. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas, Madrid (Spain). 1988. 38p. (In Spanish). Order Number DE90623347. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It makes easier the mechanization of a 'General File' for a great Center as it allows the management, storage, maintenance and retrieval of all the circulating documents, involving any unit or section, to be considered officially or not. Shortly, it is a system which makes possible the inclusion, within the same Data Base, of references to official and unofficial documents of different classes, as well as document associated with them, under a number of registration correlative for each document and originated by the application. (Author). 7 Fig.

27355 (CONF-9004161–1) **SIGNIF, a "C" function to compute significant digits.** Horwedel, B.M.; Horwedel, J.E. Oak Ridge National Lab., TN (USA). [1990]. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From SAS user group international conference (SUGI-15); Nashville, TN (USA); 1-4 Apr 1990. Order Number DE90009242. Available from NTIS, PC A03/MF A01 - OSTI.

This poster presents a C function, SIGNIF, that can be called from a SAS program to return a value rounded to a specified number of significant digits. The rules for rounding a number to n significant digits as implemented by SIGNIF are: truncate the number to n digits, and treat the excess digits as a decimal fraction; if the fraction is greater than 1/2, increment the least significant digit; if the fraction is less than 1/2, do not increment; if the fraction equals 1/2, increment the least significant digit only if it is odd.

27356 (DOE/ER/13190–6) **Singularity structure of nonlinear ordinary and partial differential equations: Progress report, February 1, 1989–October 1, 1989.** Columbia Univ., New York, NY (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER13190. Order Number DE90009583. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Short communication. PARTIAL DIFFERENTIAL EQUATIONS/ singularity; SINGULARITY; PROGRESS REPORT; NONLINEAR PROBLEMS

27357 (DP-MS–88-103) **Savannah River data banks for probabilistic risk assessment.** Durant, W.S.; Lux, C.R.; Pritchard, P.R.; Galloway, W.D. Savannah River Lab., Aiken, SC (USA). [1989]. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-890405–28: PSA '89: international topical meeting on probability, reliability and safety assessment, Pittsburgh, PA (USA), 2-7 Apr 1989). Order Number DE90009130. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Savannah River Laboratory maintains a compilation of operating problems and equipment failures that have occurred in the fuel reprocessing areas of the Savannah River Plant. The data bank contains more than 200,000 entries, ranging from minor equipment malfunctions to incidents with potential for injury or contamination of personnel, or for economic loss. The data bank has been used extensively for a wide variety of purposes such as probabilistic risk assessment, failure analysis, and trend analysis. 10 refs., 2 figs., 2 tabs.

27358 (ENEA-RT-TIB–87-67) **Spectral properties of the undulator magnets radiation: Analytical and numerical treatment.** Barbini, R.; Ciocci, F.; Dattoli, G.; Giannessi, L. ENEA, Frascati (Italy). Centro Ricerche Energia. Feb 1989. 98p. (RT/TIB–87-67). Order Number DE90764297. Available from NTIS (US Sales Only), PC A05/MF A01.

In this paper we present a comprehensive review of the spectral features of the radiation emitted by an electron moving in a magnet undulator. We discuss two methods of analysis. The first is based on the so called Bessel function expansion and the second is based on the evaluation of the Lienard-Wiechert integral using a numerical technique known as SINLUCE code. We discuss the relative advantages offered by each method and then we analyze some specific applications. The possibility of exploiting the undulator radiation as a test of the e-beam and undulator qualities is also briefly discussed.

27359 (ENEA-RT-TIB–88-53) **Lie algebraic methods and solutions of linear partial differential equations.** Dattoli, G.; Richetta, M.; Schettini, G.; Torre, A. ENEA, Frascati (Italy). Centro Ricerche Energia. Sep 1989. 33p. (RT/TIB–88-53). Order Number DE90764303. Available from NTIS (US Sales Only), PC A03/MF A01.

Submitted to Journal of Mathematical Physics.

This paper discusses an algebraic method to get the solution of linear partial differential equations of the evolution type. The proposed method consists in the use of Lie differential operators and their matrix realization to reduce the equation to an easily solvable generalized spinorial form. Some applications to problems of specific interest are also discussed. The Authors, examining an SU(3) generalization, show how the treatment of SU(2) and SU(1,1) groups can be extended to groups with higher dimensionality.

27360 (ENEA-RT-TIB–89-47) **An expert system for the evaluation of uncertainties related to systematic experimental errors.** Martinelli, T.; Panini, G.C.; Amoroso, A. ENEA, Casaccia (Italy). Dipt. Tecnologie Intersettoriali di Base. Nov 1989. 28p. (In Italian). (RT/TIB–89-47). Order Number DE90764292. Available from NTIS (US Sales Only), PC A03/MF A01.

Information about systematic errors are not given in EXFOR, the data base of nuclear experimental measurements; their assessment is committed to the ability of the evaluator. A tool is needed which perform this task in a fully automatic way or, at least, gives a valuable aid. The expert system ERESYE was implemented for investigating the feasibility of an automatic evaluation of the systematic errors in the experiments. The features of the project which led to the implementation of the system are presented.

27361 (FNAL/C–90/21) **Status of HEP [High Energy Physics] neural NET research in the USA.** Denby, B. (Fermi National Accelerator Lab., Batavia, IL (USA)); Linn, S.L. Fermi National Accelerator Lab., Batavia, IL (USA). Jan 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-890415–13: Computing in high energy physics, Oxford (UK), 10-14 Apr 1989). Order Number DE90009078. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Progress on tracking with recurrent neural networks is presented. Applications of feed forward networks to High Energy Physics are discussed. The situation regarding hardware implementations of neural networks is assessed. 10 refs., 3 figs.

27362 (KAERI/RR–724/88) **Study of nuclear computer code maintenance and management system.** Ryu, Chang Mo (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Kim, Yeon Seung; Eom, Heung Seop; Lee, Jong Bok; Kim, Ho Joon; Choi, Young Gil; Kim, Ko Ryeo. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Jan 1989. 146p. (In Korean). Order Number DE90623348. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Software maintenance is one of the most important problems since late 1970's.We wish to develop a nuclear computer code system to maintenance and manage KAERI's nuclear software. As a part of this system, we have developed three code management programs for use on CYBER and PC systems. They are used in systematic management of computer code in KAERI. The first program is embodied on the CYBER system to rapidly provide information on nuclear codes to the users. The second and the third programs were embodied on the PC system for the code manager and for the management of data in korean language, respectively. In the requirement analysis we defined each code, magnetic tape, manual and abstract information data. In the conceptual design, we designed retrieval, update, and output functions. In the implementation design, we described the technical considerations of database programs, utilities, and directions for the use of databases. As a result of this research, we compiled the status of nuclear computer codes which belonged KAERI until September, 1988. Thus, by using these three database programs, we could provide the nuclear computer code information to the users more rapidly. (Author).

27363 (LA-UR–90-378) **Artificial life: The coming evolution.** Farmer, J.D. (Los Alamos National Lab., NM (USA)); Belin, A.d'A. Los Alamos National Lab., NM (USA). 1990. 26p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-891131–: Indirect liquefaction contractors' review meeting, Pittsburgh, PA (USA), 13-15 Nov 1989). Order Number DE90008860. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Within fifty to a hundred years a new class of organisms is likely to emerge. These organisms will be artificial in the sense that they will originally be designed by humans. However, they will reproduce, and will evolve into something other than their initial form; they will be "alive" under any reasonable definition of the word. These organisms will evolve in a fundamentally different manner than contemporary biological organisms, since their reproduction will be under at least partial conscious control, giving it a Lamarckian component. The pace of evolutionary change consequently will be extremely rapid. The advent of artificial life will be the most significant historical event since the emergence of human beings. The impact on humanity and the biosphere could be enormous, larger than the industrial revolution, nuclear weapons, or environmental pollution. We must take steps now to shape the emergence of artificial organisms; they have potential to be either the ugliest terrestrial disaster, or the most beautiful creation of humanity. 22 refs., 3 figs.

27364 (LA-UR–90-761) **Aperiodicity in one-dimensional cellular automata.** Jen, E. Los Alamos National Lab., NM (USA). [1990]. 21p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8908218–1: AIP US-Soviet conference on chaos, Woods Hole, MA (USA), 5-9 Aug 1989). Order Number DE90008947. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Cellular automata are a class of mathematical systems characterized by discreteness (in space, time, and state values), determinism, and local interaction. A certain class of one-dimensional, binary site-valued, nearest-neighbor automata is shown to generate infinitely many aperiodic temporal sequences from arbitrary finite initial conditions on an infinite lattice. The class of automaton rules that generate aperiodic temporal sequences are

characterized by a particular form of injectivity in their interaction rules. Included are the nontrivial "linear" automaton rules (that is, rules for which the superposition principle holds); certain nonlinear automata that retain injectivity properties similar to those of linear automata; and a wider subset of nonlinear automata whose interaction rules satisfy a weaker form of injectivity together with certain symmetry conditions. A technique is outlined here that maps this last set of automata onto a linear automaton, and thereby establishes the aperiodicity of their temporal sequences. 12 refs., 3 figs.

27365 (LA-UR–90-878) **Is there a sharp phase transition for deterministic cellular automata?.** Wootters, W.K. (Santa Fe Inst., NM (USA)); Langton, C.G. Los Alamos National Lab., NM (USA). [1990]. 30p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8909298–2: NATO conference on cellular automata, Los Alamos, NM (USA), 6-9 Sep 1989). Order Number DE90008914. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Previous work has suggested that there is a kind of phase transition between deterministic automata exhibiting periodic behavior and those exhibiting chaotic behavior. However, unlike the usual phase transitions of physics, this transition takes place over a range of values of the parameter rather than at a specific value. The present paper asks whether the transition can be made sharp, either by taking the limit of an infinitely large rule table, or by changing the parameter in terms of which the space of automata is explored. We find strong evidence that, for the class of automata we consider, the transition does become sharp in the limit of an infinite number of symbols, the size of the neighborhood being held fixed. Our work also suggests an alternative parameter in terms of which it is likely that the transition will become fairly sharp even if one does not increase the number of symbols. In the course of our analysis, we find that mean field theory, which is our main tool, gives surprisingly good predictions of the statistical properties of the class of automata we consider. 18 refs., 6 figs.

27366 (LA-UR–90-955) **Stability of a solitary wave solution to a set of coupled Boussinesq-like equations.** Christiansen, P.L. (Naples Univ. (Italy). Dipt. di Matematica e Applicazioni); Rionero, S.; Lomdahl, P.S.; Muto, V. Los Alamos National Lab., NM (USA). [1989]. 12p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8910207–2: 5. international conference on waves and stability in continuous media, Sorrento (Italy), 9-14 Oct 1989). Order Number DE90008927. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A set of coupled partial differential equations of Boussinesq type are derived in the continuum limit of a Toda lattice with a transverse degree of freedom. The stability of a new hybrid wave solution with longitudinal and transversal components is investigated by approximate calculation of the Hamiltonian for infinitesimal displacement of the longitudinal and transversal strains relatively and by numerical solution. 4 refs., 6 figs.

27367 (LBL–28275) **Specifying dynamic models in the Simulation Problem Analysis Kernel.** Moshier, M.A. (California Univ., Los Angeles, CA (USA)); Sowell, E.F. Lawrence Berkeley Lab., CA (USA). 15 Oct 1989. 22p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. (CONF-900182–1: Computer simulation 1990 multiconference, San Diego, CA (USA), 17-19 Jan 1990). Order Number DE90009064. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Simulation Problem Analysis Kernel (SPANK) is a prototype implementation of the Energy Kernel System (EKS). It is intended to demonstrate some of the features that have been argued as necessary for future simulation systems. In particular, with earlier versions of SPANK, the model designer can specify static behavior as modeled by systems of algebraic equations. More recent work has led to extensions that allow the designer to specify dynamic behavior as modeled by systems of equations together with certain predefined integration methods. One drawback of this approach is that the integration methods must be of a specific kind involving at most a fixed number of values from previous time steps. In this paper,we propose to extend SPANK in a more flexible way to give the designer the ability to specify any of the standard difference methods for initial value problems. These include Runge-Kutta methods as well as predictor-corrector methods, The development of our extensions begins with a close look at how the static version of SPANK specifies models. On this foundation, we then look at two very simple integration methods, Euler's implicit and explicit methods, for clues as to how we can extend the system description language to admit dynamics, With the extensions to SPANK called for by looking at Euler's methods, we show that Runge-Kutta and predictor-corrector methods can also be specified. From this, we argue that the extensions proposed herein are suitable for specifying arbitrary finite difference integration methods. We conclude with a brief discussion of further extensions that we believe would make the SPANK system more useful for dynamic simulations. 15 figs., 7 figs.

27368 (PB–90-152190/XAB) **Supercomputers, Monte Carlo simulation, and regression analysis. Research memo.** Kleijnen, J.P.C.; Annink, B. Tilburg Univ. (Netherlands). Dept. of Economics. Aug 1989. 31p. (FEW–402). Available from NTIS, PC A03/MF A01.

The paper focuses on the use of supercomputers in Monte Carlo experiments with multivariate regression analysis. Supercomputers provide a new tool for management scientists. The application of this tool requires thinking in parallel or vector mode. The parallel mode needs to exploit a specific dimension of the Monte Carlo experiment (namely the replicates of that experiment). Then Ordinary Least Squares on a CYBER 205 takes only 1.4% of the time needed on a VAX 8700. Estimated Generalized Least Squares, however, is slower on the CYBER 205 because it requires matrix inversion.

27369 (PB–90-153958/XAB) **Parallel approach to graduated nonconvexity on an SIMD machine.** Kashko, A. Queen Mary Coll., London (UK). Dept. of Computer Science. 1990. 36p. Available from NTIS, PC EE05/MF E05.

A parallel implementation of the Blake-Zisserman Graduated Nonconvexity method for surface reconstruction and edge detection in the presence of noisy data is described. The performances of the serial and parallel programs are compared.

27370 (PB–90-154121/XAB) **Design of a parallel language.** Weisbecker, J.R. Queen Mary Coll., London (UK). Dept. of Computer Science. 1 Jun 1988. 19p. Available from NTIS, PC EE04/MF E04.

Concurr is a new language for parallel systems. The language is designed as an easy-to-use parallel programming facility. The language also attempts to overcome some unnatural restrictions of previous sequential languages. Clearly, new languages are needed to exploit the inherent parallelism in problem solutions, but at present, there is a division of opinion on whether the parallelism should be explicit or implicit within a language. Concurr is presently being developed for a Meiko/Transputer Computing Surface and an AMT Distributed Array Processor (DAP) to provide MIMD and SIMD configurations respectively, but as noted, the language itself is not dependent on specific hardware architectures.

27371 (PB–90-155060/XAB) **Finite elements using long vectors of the DAP.** Lai, C.H.; Liddell, H.M. Queen Mary Coll., London (UK). Dept. of Computer Science. Jun 1987. 25p. Available from NTIS, PC EE04/MF E04.

The Finite Element Method for solving partial differential equations using the long vector mode of the distributed array processor (DAP) is presented. First, the implementation of finite elements using a long vector mode of the DAP is given, followed by the treatment of boundary conditions and the solution of the finite element equations using a parallel conjugate gradient method. Two solution procedures of the parallel conjugate gradient method, first without global matrix assembly and second with global matrix assembly, are presented and their advantages and disadvantages are discussed. Preconditions of the conjugate gradient method using iteration methods are also discussed and results include a 1-step point Jacobi preconditioner, a m-step point Jacobi preconditioner and a m-step multi-color preconditioner. Finally long vector implements for multinodes per processor using a sliced mapping technique and domain decomposition are included.

27372 (PNL–7264) **Archaeological survey of the 200 East and 200 West Areas, Hanford Site, Washington.** Chatters, J.C.; Cadoret, N.A. Pacific Northwest Lab., Richland, WA (USA). Mar

1990. 23p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90009354. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Responding to a heavy demand for cultural resource reviews of excavation sites, the Westinghouse Hanford Company contracted with Pacific Northwest Laboratory to conduct a comprehensive archaeological resource review for the 200 Areas of the Hanford Site, Washington. This was accomplished through literature and records review and an intensive pedestrian survey of all undisturbed portions of the 200 East Area and a stratified random sample of the 200 West Area. The survey, followed the Secretary of the Interior's guidelines for the identification of historic properties. The result of the survey is a model of cultural resource distributions that has been used to create cultural resource zones with differing degrees of sensitivity. 11 refs., 7 figs., 1 tab.

27373 (PNL-SA–17447) **A manager's methodology for evaluating potential KBS applications.** Laufmann, S.C. (USWest Advanced Technologies, Englewood, CO (USA)); DeVaney, D.M.; Melton, R.B.; Whiting, M.A. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-9003130–1: 1990 IEEE conference on artificial intelligence applications, Santa Barbara, CA (USA), 5-9 Mar 1990). Order Number DE90009179. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

It is often difficult in analyzing potential KBS applications to assess the match between the tasks involved in a particular application and the current state of the art in KBS development paradigms and techniques. It is not unusual for managers and KBS practitioners to invest significant time discussing a potential application before discovering properties that make it an undesirable candidate for the application of KBS technologies. Artificial intelligence literature contains little advice to assist in identifying those tasks with a high potential for success KBS solutions. The bulk of this information typically is reported in short lists of "tips" for analyzing KBS applicability or for expediting KBS development. This report describes a technique for use by managers in assessing potential KBS applications. The technique is one phase of a more comprehensive methodology developed at Pacific Northwest Laboratory (PNL) for evaluating KBS applications which also includes a rigorous phase for technical assessment by KBS practitioners. The assessment methodology has been automated via a Hypercard® application called "Inside Knowledge™," also built at PNL. We briefly describe the application. 8 refs., 1 fig.

27374 (SAND–89-2685C) **Toward a new CIM [computer integrated manufacturing] Sandia Laboratories.** Yoder, J.R. Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005152–1: CIMCOM '90: International conference on CIM architecture, Gaithersburg, MD (USA), 22-24 May 1990). Order Number DE90008677. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Sandia National Laboratories has experienced several generations of design and engineering automation. Each successive iteration brought improvement to a specific function. The changes in technology were point optimized, i.e., the improvements were made to narrow functional areas and not necessarily to the entire organization. Further, implementation plans rarely included the transfer of information from one function to another. Consequently, the Laboratories began a significant effort to design an overall architecture under which integration of disparate activities could take place and which would serve to provide an information path between all functions. This paper describes the current version of the architecture and provides a description of the process that led to the architecture. 6 refs., 6 figs.

27375 (SAND–89-2872C) **Multigrid on massively parallel computers.** Womble, D.E. (Sandia National Labs., Albuquerque, NM (USA)); Young, B.C. Sandia National Labs., Albuquerque, NM (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. (CONF-9004159–1: 5. distributed memory computing conference, Charleston, SC (USA), 9-12 Apr 1990). Order Number DE90008999. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Multigrid is a fast iterative method used to solve linear partial differential equations. However, because the solution of very small problems is inherent in the multigrid iteration, it is difficult to implement efficiently on a massively parallel computer. In this paper, we present an implementation of the multigrid v-cycle that has achieved 84% efficiency on the 1,024 processor NCUBE/ten. We also present a model for the efficiency of multigrid on a parallel computer that depends only on the efficiency of the smoother at each level. This model can be used to verify that it is indeed difficult to obtain extremely high efficiencies (95% to 100%), but that it is relatively easy to obtain moderately high efficiencies (70% to 85%). 9 refs., 2 figs.

27376 (SAND–90-0482C) **The CAD/CAM product data standards, IGES/PDES [Initial Graphics Exchange Specification/ Product Data Exchange Standards]: The present and the future.** Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005151–1: 1990 Update for standards in industrial automation: Status and future, St. Louis, MO (USA), 14-16 May 1990). Order Number DE90008803. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Initial Graphics Exchange Specification (IGES) has more capability than most people infer from the name. It can already provide some product data for manufacturing and test of products and, in particular, products having electrical and electronic aspects. The Product Data Exchange Specification (PDES) promises to do even better. Both of these efforts address the demonstrated need to move product descriptions from one computer-aided system to another in a way that maximizes the utility of the data received. Receiving systems can use these product descriptions (usually after some augmentation) to perform simulations, numerically controlled fabrication operations, process planning and variety of inspections and tests. PDES is expected to support Computer Integrated Manufacturing with the emphasis on "Integrated."

27377 (SOL–90-7) **A monotone complementarity problem in Hilbert space.** Yao, Jen-Chih. Stanford Univ., CA (USA). Systems Optimization Lab. Apr 1990. 5p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation. DOE Contract FG03-87ER25028. Grant DMS-8913089;Grant N00014-89-J-1659. Order Number DE90009755. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An existence theorem for a complementarity problem involving a weakly coercive monotone mapping over an arbitrary closed convex cone in a real Hilbert space is established. 8 refs.

27378 (UCRL–53918) **A parallel multigrid method for solving elliptic partial differential equations.** Ferretta, T.E. Lawrence Livermore National Lab., CA (USA). Feb 1989. 76p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. Order Number DE90007929. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This paper introduces a parallel multigrid method for solving elliptic partial differential equations. This method combines two other methods, both of which are popular methods under research today. One of the methods is a multigrid method, essentially a sequential method. The other is a parallel domain decomposition method, a variation on the Schwarz alternating procedure. Each method is explained individually, before the combined method is explained. The combined method is then compared to each of the individual methods, demonstrating the superiority of the combined method over each of its parent methods. As a model problem Poisson's equation is used. The computer on which the various methods were tested is an Alliant FX/8, a shared memory multiprocessor machine having 8 processors which can be run simultaneously is executing parallel code. 19 refs.

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Refer also to citation(s) 25431, 25590, 25616, 25838, 25907, 25908, 25986, 26447, 27051, 27354, 27360

27379 (AD-A–216283/2/XAB) **Analysis of the impacts of computer-based information system on research and development organizations. Master's thesis.** Sarmiento, G.H. Air Force

Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Systems and Logistics. Sep 1989. 121p. (AFIT/GSM/LSY–89S-33). Available from NTIS, PC A06/MF A01.

Today, more and more organizations are turning towards computer-based information systems to help them deal with the complexities brought on by the Information Society. These computer based information systems are impacting all levels of the organizations. This research effort was a study involving the impact of a computer-based information system at a USAF research and development organization. A key aspect of the study was to attempt to identify if any demographic groups perceived themselves to be impacted by the CBIS more than others. The results show that a CBIS was perceived by the respondents to impact organizational communication and organization tasks. Communication within sub-units, between sub-units, and throughout the organization were perceived to be enhanced. In addition, the findings indicate that those members willing to use the system perceived a positive impact on task efficiency and task coordination. Interestingly, the respondents reported that the information system had not reduced their task workload. However, the findings show that the impacts to the organizational hierarchy were mixed.

27380 (DOE/ER/13494–T1) **Reference data in support of energy programs: Final report.** Chase, M.W. National Inst. of Standards and Technology, Gaithersburg, MD (USA). 19 Mar 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AI01-86ER13494. Order Number DE90009056. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Standard Reference Data (SRD) of the National Institute of Standards and Technology conducted a program for compilation and evaluation of physical, chemical, and materials properties data relevant to energy research and development. This report provides a description of the manner in which the program was run and a report of the results. The basis for DOE support for this program on reference data was the realization that data from the results of basic and applied research need to be compiled and evaluated in order to: (a) more effectively transfer research results into development and process design, (b) build a body of reliable data on which estimation and prediction methods can be based, and (c) provide guidance to researchers about gaps in available data and areas in which further research is needed.

27381 (INDC(NDS)–231/L+R) **Nuclear data for radiation damage assessment and related safety aspects: Advisory group meeting, Vienna, 19-22 September 1989. Summary report.** Kocherov, N.P. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Dec 1989. 25p. (CONF-8909234–: Advisory group meeting on nuclear data for radiation damage assessment and related safety aspects, Vienna (Austria), 19-22 Sep 1989). Order Number DE90623344. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The IAEA Advisory Group Meeting on Nuclear Data for Radiation Damage Assessment and Related Safety Aspects was held at the IAEA Headquarters in Vienna, 19-22 September 1989. This report contains the conclusions and recommendations of this meeting. The papers which the participants prepared for and presented at the meeting will be published as an IAEA Technical Document. (author).

27382 (KFK-PEF–50-Vol.2, pp. 765-777) **Information system for environmental technologies.** Rentz, O. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Inst. fuer Industriebetriebslehre und Industrielle Produktion); Hackenberg, D.; Hillenbrand, R. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Apr 1989. (In German). (CONF-8903205–Vol.2: 5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H., Karlsruhe (Germany, F.R.), 7-9 Mar 1989). In *5. status colloquium of the PEF project, on March 7-9, 1989 at Karlsruhe Nuclear Research Center.* Order Number DE90767679. Available from NTIS (US Sales Only), PC A19/MF A01.

For documentation, analysis and application of the state of the art and its development in environmental technologies, an information system should be conceived by using modern information and communication techniques. Within this project the pilot phase is being carried out, in which in cooperation with the established working party (industry, host and authorities) a test data bank is being implemented including emission control technologies of combustion systems, which emphasises the experience of applied emission control systems. For the model description of the emission control technologies into the data bank a special method was developed. Moreover a user structure system is shown, which allows for efficient access to the information without using a seperate search language. (orig.).

27383 (LBL–28103) **STORM: A STatistical Object Representation Model.** Rafanelli, M. (Istituto di Analisi dei Sistemi ed Informatica, Rome (Italy)); Shoshani, A. Lawrence Berkeley Lab., CA (USA). Nov 1989. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90009048. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this paper we explore the structure and semantic properties of the entities stored in statistical databases. We call such entities "statistical objects" (SOs) and propose a new "statistical object representation model," based on a graph representation. We identify a number of SO representational problems in current models and propose a methodology for their solution. 11 refs.

27384 (PB–90-154345/XAB) **Microcomputer-based information storage and retrieval system using a filter (fast in-line text engine for retrieval).** Barros, S.P.V.; Ng, Y.H. Queen Mary Coll., London (UK). Dept. of Computer Science. 1990. 26p. Available from NTIS, PC EE05/MF E05.

The architecture of an ISR system is proposed for Office text information management. The basic functions (Add, Amend, Delete and Compress) are considered in terms of the priorities normally required in the Office environment; viz: High Performance, Comprehensive Retrieval Criteria, Simplicity in use and Low cost. A FILTER model is employed to execute retrievals on-the-fly. A SAP implementation of the model is proposed for parallel execution of the text retrieval algorithms. The experimental evaluations indicate that the proposed system is an effective solution for Office information management applications.

27385 (SAND–88-1078-Rev.) **Sandia National Laboratories and higher education in New Mexico: Revision.** Fairbanks, R.R. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 27p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC04-76DP00789. Order Number DE90008650. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Supersedes SAND–88-1078 dated May 1988.

New Mexico education institutions have had an extraordinary influence on the Sandia workforce throughout the years. Today, our approximately 8400 employees hold 2028 graduate and undergraduate degrees from the 4-year colleges and universities in the state. This accounts for 22.3% of the degrees held by Sandia employees. Employees also hold another 618 2-year degrees from New Mexico educational institutions. The total number of degrees is nearly twice the number from the next leading state, California. When only the highest degree held by an employee is considered, that degree (PhD, master, or bachelor's) came from a New Mexico college or university 29% of the time. Employees whose highest degree is from the University of New Mexico (UNM) rank, in numbers, at the top of most categories of management and staff at Sandia Albuquerque. UNM, with its proximity to our headquarters in Albuquerque, has granted the most degrees to Sandia employees. Employees also hold degrees from New Mexico State University (NMSU). New Mexico Institute of Mining Technology (NMIMT), and from other 4-year regional institutions in the state. Engineering degrees and degrees in business are the most numerous, although employees hold degrees in many other fields, reflecting the diversity of work being done at the Laboratories by graduates of colleges and universities in the state. For more detailed information, refer to Appendix A. 4 figs., 11 tabs.

27386 (SAND–90-0871C) **The ultimate CASE [Computer-Aided Software Engineering] tool.** Sharp, J.K. Sandia National Labs., Albuquerque, NM (USA). [1990]. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789.

(CONF-900530–3: Conference on lasers and electro-optics, Anaheim, CA (USA), 21-25 May 1990). Order Number DE90009351. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The theory and practice of information engineering is being actively developed at Sandia National Laboratories. The main output of Sandia is information. Information is created, analyzed and distributed. It is the life blood of our design laboratory. The proper management of information will have a large, positive impact on staff productivity. In order to achieve the potential benefits of shared information a commonly understood approach is needed, and the approach must be implemented in a CASE (Computer-Aided Software Engineering) tool that spans the entire life cycle of information. The commonly understood approach used at Sandia is natural language. More specifically, it is a structured subset of English. Users and system developers communicate requirements and commitments that they both understand. The approach is based upon NIAM (Nijssen's Information Analysis Methodology). In the last three years four NIAM training classes have been given at Sandia. The classes were all at the introductory level, with the latest class last October having an additional seminar highlighting successful projects. The continued growth in applications using NIAM requires an advanced class. The class will develop an information model for the "Ultimate CASE Tool." This paper presents the requirements that have been established for the "Ultimate CASE Tool" and presents initial models. 4 refs., 1 tab.

Corporate Author Index

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See references guide users from synonymous terms to the descriptors selected for the concept. *See also* references indicate subject concepts that are more specific than a particular descriptor. To gain complete subject coverage, all such terms should be reviewed.

A

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See MESONS

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CONF-870410–		(193. national meeting of the American Chemical Society; Denver, CO (USA); 5-10 Apr 1987)			
42	15:27335	*See* HEDL-SA–3676			
CONF-8704394–		(American Society for Quality Control (ASQC) meeting; Richland, WA (USA); 20 Apr 1987)			
1	15:25808	*See* HEDL-SA–3706			
CONF-870963–		(Electric thermal storage conference and exposition; Binghamton, NY (USA); 22-24 Sep 1987)			
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CONF-8805223–		(20. Polish seminar on positron annihilation; Piechowice (Poland); 15-21 May 1988)			
	15:26417	*See* ZfK–637			
CONF-880601–		(American Nuclear Society annual meeting; San Diego, CA (USA); 12-16 Jun 1988)			
56	15:26782	*See* DP-MS–88-24			
CONF-880607–		(33. ASME international gas turbine and aeroengine congress and exposition; Amsterdam (Netherlands); 5-8 Jun 1988)			
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	15:25922	*See* EPRI-GS/NP–6670			
CONF-880813–		(9. international congress on thermal analysis (ICTA); Jerusalem (Israel); 21-25 Aug 1988)			
3	15:26438	*See* ENEA-RT-TIB–88-40			
CONF-8809123–		(International congress on optical science and engineering; Hamburg (Germany, F.R.); 13-23 Sep 1988)			
3	15:26435	*See* ENEA-RT-TIB–88-36			
CONF-8810135–		(Switched-power workshop; Shelter Island, NY (USA); 16-21 Oct 1988)			
	15:26499	*See* BNL–52211			
CONF-8810305–		(15. Meeting of the Association pour les Techniques et les Sciences de Radioprotection on Dismantling of Nuclear Plants, Wastes and Associated Problems of Radiation Protection; Grenoble (France); 5-7 Oct 1988)			
	15:25537	*See* CEA-CONF–9889			
CONF-881049–		(14. linear accelerator conference (LINAC-14); Newport News, VA (USA); 3-7 Oct 1988)			
	15:26451	*See* DOE/ER/40150–126			
CONF-8810490–		(International workshop on theory of fusion plasmas; Chexbres (Switzerland); 3 Oct 1988)			
Exc.	15:27274	*See* ENEA-RT-FUS–88-17			
CONF-881056–		(19. European conference on laser interaction with matter (ECLIM); Madrid (Spain); 3-7 Oct 1988)			
Exc.	15:27323	*See* ENEA-RT-FUS–88-19			
CONF-881066–		(12. international symposium on the scientific basis for nuclear waste management; Berlin (Germany, F.R.); 10-13 Oct 1988)			
	15:25539	Materials Research Society, 9800 McKnight Road, Suite 327, Pittsburgh, PA 15237			ND-510

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CONF-8811318–		(IIASA energy conference; Laxenburg (Austria); 15 Nov 1988)			
1	15:26652	*See* PNL-SA–16399			
CONF-890001–		(Conference on thirty year of the Aharonov-Bohm effect; Columbia, SC (USA);			
1	15:27079	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009034	MF-414
CONF-8901184–		(Advisory group on prompt gamma neutron activation analysis in borehole logging and industrial process control; Vienna (Austria); 30 Jan - 3 feb 1989)			
	15:26282	*See* IAEA-TECDOC–537			
CONF-890197–		(Workshop on advanced accelerator concepts; Lake Arrowhead, CA (USA); 9-13 Jan 1989)			
	15:26498				
CONF-890199–		(24. Rencontre de Moriond on tests of fundamental laws in physics; Les Arcs (France); 21-28 Jan 1989)			
	15:26513	*See* LAPP-EXP–89-04			
CONF-8902170–		(3. regional conference on mathematical physics; Islamabad (Pakistan); 18-24 Feb 1989)			
	15:27249	*See* NBI-HE–89-59			
CONF-890302–		(16. European conference on controlled fusion and plasma physics; Venice (Italy); 13-17 Mar 1989)			
Exc.	15:27256	*See* ENEA-RT-FUS–89-01			
CONF-8903205–		(5. annual report on research program for air pollution prevention measures of Kernforschungszentrum Karlsruhe G.m.b.H.; Karlsruhe (Germany, F.R.); 7-9 Mar 1989)			
Vol.1	15:26581	*See* KFK-PEF–50-Vol.1			
Vol.2	15:26582	*See* KFK-PEF–50-Vol.2			
CONF-890333–		(9. general conference of the Condensed Matter Division of the European Physical Society; Nice (France); 6-9 Mar 1989)			
	15:26270	*See* CEA-CONF–9835			
CONF-890335–		(1989 IEEE particle accelerator conference; Chicago, IL (USA); 20-23 Mar 1989)			
275	15:26502	*See* LBL–26028			
CONF-890405–		(PSA '89: international topical meeting on probability, reliability and safety assessment; Pittsburgh, PA (USA); 2-7 Apr 1989)			
28	15:27357	*See* DP-MS–88-103			
CONF-890415–		(Conference on computing in high energy physics; Oxford (UK); 10-14 Apr 1989)			
	15:26518	*See* MPI-PAE/Exp.El.–216			
13	15:27361	*See* FNAL/C–90/21			
CONF-890421–		(91. annual meeting of the American Ceramic Society; Indianapolis, IN (USA); 23-27 Apr 1989)			
12	15:26146	*See* LBL–27360			
CONF-8904242–		(International congress on optical science and engineering; Paris (France); 24-28 Apr 1989)			
5	15:26441	*See* ENEA-RT-TIB–89-17			
CONF-8904268–		(56. international conference of Doble Clients; Boston, MA (USA); 10 Apr 1989)			
2	15:25832	*See* ENEL–420.560.1			
CONF-8904329–		(1989 intermag conference; Washington, DC (USA); Apr 1989)			
1	15:26079	*See* LA-UR–90-1113			
CONF-890478–		(12. world conference on non-destructive testing; Amsterdam (Netherlands); 23-28 Apr 1989)			
	15:26412	*See* CEA-CONF–9868			
	15:26413	*See* CEA-CONF–9870			
CONF-8905183–		(Workshop on physics at the main injector; Batavia, IL (USA); 16-18 May 1989)			
5	15:27053	*See* DOE/ER–3072-54			

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CONF-8905232–		(4. workshop on perspectives in nuclear physics at intermediate energies; Trieste (Italy); 8-12 May 1989)			
	15:27032	*See* RAL–89-111			
CONF-8905272–		(NASA workshop on physics from a lunar base; Stanford, CA (USA); 19 May 1989)			
	15:27022	American Inst. of Physics, 335 E. 45th St., New York, NY 10017			
CONF-8905283–		(SHIM 89: 1. international symposium on swift heavy ions in matter; Caen (France); 16-19 May 1989)			
	15:26127	*See* CEA-CONF–9902			
CONF-8905297–		(CIGRE SC 13; Sarajevo (Yugoslavia); May 1989)			
1	15:25831	NTIS (US Sales Only), PC A03/MF A01		DE90764278	
CONF-8905298–		(Environmental research conference on groundwater quality and waste disposal; Washington, DC (USA); 2-4 May 1989)			
	15:26765	*See* EPRI-EN–6749			
CONF-890546–		(ICHMT international seminar on fission product transport processes in reactor accidents; Dubrovnik (Yugoslavia); 22-26 May 1989)			
	15:25771	*See* CEA-DAS–613			
CONF-890554–		(3. world conference on neutron radiography; Osaka (Japan); 14-18 May 1989)			
4	15:26275	*See* DP-MS–88-225			
CONF-890565–		(11. annual ESARDA symposium on safeguards and nuclear materials management; Esarda (Luxembourg); 30 May - 1 jun 1989)			
	15:26271	*See* CEA-CONF–9901			
CONF-890580–		(Symposium on beam processing and laser chemistry; Strasbourg (France); 30 May - 2 jun 1989)			
1	15:26210	*See* ENEA-RT-TIB–89-26			
CONF-890607–		(3. international conference on fly ash, silica fume, slag, and natural pozzolans in concrete; Trondheim (Norway); 19-26 Jun 1989)			
2-Rev.2	15:25558	*See* DP-MS–87-95-Rev.2			
CONF-8906159–		(6. conversation in the discipline biomolecular stereodynamics; Albany, NY (USA); 6-10 Jun 1989)			
4	15:26849	*See* LA-UR–90-758			
CONF-8906200–		(Large area electron beam diode workshop; Monterey, CA (USA); 7 Jun 1989)			
5	15:27340	*See* SAND–89-1483C			
CONF-8906210–		(Workshop on B-factories and related physics issues; Blois (France); 26 Jun - 1 jul 1989)			
	15:27064	*See* IC–89/260			
	15:27065	*See* IC–89/261			
CONF-8906225–		(Physics of classical novae: IAU colloquium no. 122; Madrid (Spain); 27-30 Jun 1989)			
4	15:27020	*See* LA-UR–90-875			
CONF-890702–		(28. international geological congress; Washington, DC (USA); 9-19 Jul 1989)			
5	15:25588	*See* UCRL–100099			
CONF-8907134–		(17. SLAC summer institute: physics at the 100 GeV mass scale; Stanford, CA (USA); 10-21 Jul 1989)			
8	15:27057	*See* LBL–28547			
CONF-8907150–		(12. course of the International School of Nuclear Physics: the nature of hadrons and nuclei studied by electron scattering; Erice (Italy); 16-25 Jul 1989)			
	15:27052	*See* BONN-ME–89-09			
CONF-8907186–		(Cambridge cosmic strings workshop; Cambridge, MA (USA); Jul 1989)			
1	15:27080	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009035	MF-414
CONF-890730–		(19. international conference on phenomena in ionized gases (ICPIG-19); Belgrade (Yugoslavia); 10-14 Jul 1989)			
2	15:26443	*See* ENEA-RT-TIB–89-21			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-890770–		(16. annual review of progress in quantitative nondestructive evaluation; Brunswick, ME (USA); 23-28 Jul 1989)			
8	15:26777	*See* UCRL–102045			
CONF-890802–		(7. synchrotron radiation instrumentation (SRI) national conference; Berkeley, CA (USA); 6-10 Aug 1989)			
26	15:26516	*See* LBL–27600			
CONF-8908154–		(3. waste reduction workshop; Burlingame, CA (USA); 29-30 Aug 1989)			
Summ.	15:25540	*See* DOE/HWP–95			
CONF-8908189–		(Workshop on probabilistic methods in quantum field theory and quantum gravity; Cargese (France); 21-27 Aug 1989)			
	15:27093	*See* NBI-HE–89-56			
CONF-8908218–		(AIP US-Soviet conference on chaos; Woods Hole, MA (USA); 5-9 Aug 1989)			
1	15:27364	*See* LA-UR–90-761			
CONF-8908219–		(Workshop on physics, braids and links; Banff (Canada); Aug 1989)			
1	15:27206	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009036	MF-414
CONF-8908220–		(39. international Institution for Production Engineering Research general assembly; Trondheim (Norway); 20-26 Aug 1989)			
1	15:26543	*See* UCRL–99806			
CONF-890833–		(14. biennial conference on reactor operating experience: plant operations - the human element; Charlotte, NC (USA); 6-9 Aug 1989)			
1	15:25799	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008886	
CONF-890864–		(3. American Glovebox Society annual conference and equipment display; Denver, CO (USA); 21-24 Aug 1989)			
6-Rev.1	15:26378	*See* DP-MS–88-66-Rev.1			
CONF-890872–		(Workshop on physics at Fermilab in the 1990's; Breckenridge, CO (USA); 15-24 Aug 1989)			
9	15:27055	*See* FNAL/C–90/37			
10	15:27060	*See* BNL–44368			
CONF-890884–		(Bioprocessing of fossil fuels workshop; Tysons Corner, VA (USA); 8-10 Aug 1989)			
	15:25257	NTIS, PC A22/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007955	MF-113
CONF-890901–		(14. world energy conference; Montreal (Canada); 17-22 Sep 1989)			
	15:25862	*See* CANWEC–CE02833			
CONF-8909216–		(DARPA/SDIO service annual charged particle beam review; Monterey, CA (USA); 18-21 Sep 1989)			
11	15:26495	*See* UCRL-JC–103152			
CONF-8909221–		(HADRON '89: 3rd international conference on hadron spectroscopy; Ajaccio (France); 23-27 Sep 1989)			
	15:27074	*See* RAL–89-113			
CONF-8909234–		(Advisory group meeting on nuclear data for radiation damage assessment and related safety aspects; Vienna (Austria); 19-22 Sep 1989)			
	15:27381	*See* INDC(NDS)–231/L+R			
CONF-8909249–					
	15:27091	*See* NBI-HE–89-48			
CONF-8909291–		(8. topical workshop on proton-antiproton collider physics; Castiglione della Pescaia (Italy); 1-5 Sep 1989)			
6	15:27058	*See* LBL–28673			
CONF-8909298–		(NATO conference on cellular automata; Los Alamos, NM (USA); 6-9 Sep 1989)			
2	15:27365	*See* LA-UR–90-878			
CONF-8909314–		(5. international precision engineering seminar; Monterey, CA (USA); 18-22 Sep 1989)			
1	15:26224	*See* UCRL–100125			
CONF-8909315–		(US/USSR cooperative agreement on physical factors in the environment; Prague (Czechoslovakia); 24 Sep - 10 oct 1989)			
1	15:26896	*See* PNL-SA–17321			

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CONF-8909317--		(1989 EPRI gas turbine procurement seminar; Atlanta, GA (USA); 14-15 Sep 1989)			
	15:26379	*See* EPRI-GS-6745			
CONF-890943--		(1. European conference on accelerators in applied research and technology (ECAART-1); Frankfurt am Main (Germany, F.R.); 5-9 Sep 1989)			
	15:27219	*See* KU-HCOE-FL2-R-89-19			
CONF-890956--		(9. international symposium on plasma chemistry and plasma equipment exhibition; Pugnochiuso (Italy); 4-8 Sep 1989)			
	15:27291	*See* IPP-III/145			
CONF-8910134--		(6. annual symposium on improving building systems in hot and humid climates; Dallas, TX (USA); 3-4 Oct 1989)			
3	15:25954	*See* BNL-43437			
CONF-8910207--		(5. international conference on waves and stability in continuous media; Sorrento (Italy); 9-14 Oct 1989)			
2	15:27366	*See* LA-UR-90-955			
CONF-8910213--		(LEOS '89 annual conference; Orlando, FL (USA); 15-16 Oct 1989)			
2	15:26532	*See* DP-MS-89-1			
CONF-8910222--		(17. water reactor safety information meeting; Rockville, MD (USA); 23-25 Oct 1989)			
20	15:25798	*See* BNL-NUREG-43041			
Vol.1	15:25812	*See* NUREG/CP-0105-Vol.1			
Vol.2	15:25813	*See* NUREG/CP-0105-Vol.2			
Vol.3	15:25814	*See* NUREG/CP-0105-Vol.3			
CONF-8910319--		(21. international thermal conductivity conference; Lexington, KY (USA); 15-18 Oct 1989)			
3	15:26408	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009428	MF-332
CONF-8910379--		(Bloch symposium; Stanford, CA (USA); 27 Oct 1989)			
1	15:26503	*See* LBL-28395			
CONF-8910380--		(Symposium on electron microscopy in plasticity; Holzhau (German Democratic Republic); 8-13 Oct 1989)			
1	15:26080	*See* LBL-26274			
CONF-8910381--		(11. North American workshop on CV's and LMXRE's; Santa Fe, NM (USA); 9-13 Oct 1989)			
1	15:27019	*See* LA-UR-90-874			
CONF-8910383--		(Workshop on intense hadron facilities and antiproton physics; Turin (Italy); 23-26 Oct 1989)			
	15:27075	*See* RAL-89-126			
CONF-891046--		(Advanced research and technology development; Morgantown, WV (USA); 3-5 Oct 1989)			
	15:25373	*See* DOE/METC-89/6108-Vol.2			
	15:25374	*See* DOE/METC-90/6108-Vol.1			
CONF-891093--		(36. American Vacuum Society national vacuum symposium; Boston, MA (USA); 23-27 Oct 1989)			
27	15:27312	*See* PPPL-2683			
CONF-891098--		(The scientific challenge of NEPA: future directions based on 20 years of experience; Knoxville, TN (USA); 24-27 Oct 1989)			
7	15:26781	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009400	MF-403
CONF-891103--		(Winter meeting of the American Nuclear Society; San Francisco, CA (USA); 26-30 Nov 1989)			
68	15:25592	*See* WSRC-RP-89-485			
CONF-8911177--		(IMOG measurement and technology subgroup on seminar on coordinate measurement machine user; Livermore, CA (USA); 14-15 Nov 1989)			
1	15:26536	*See* UCRL-102937			
CONF-891119--		(Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989)			
114	15:27221	*See* LBL-27503			
115	15:26147	*See* LBL-28194			
116	15:26284	*See* UCRL-JC-103340			

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117	15:26432	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009235	MF-332
CONF-891131–		(Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989)			
	15:27363	*See* LA-UR–90-378			
CONF-891179–		(Workshop on dynamical issues in combustion theory; Minneapolis, MN (USA); 13-17 Nov 1989)			
1	15:26552	*See* LA-UR–90-898			
CONF-891195–		(5. Brookhaven National Laboratory workshop on synchrotron x-ray lithography; Upton, NY (USA); 16-17 Nov 1989)			
Summ.	15:26510	*See* BNL–52230			
CONF-891202–		(4. thermal performance of the exterior envelopes of buildings; Orlando, FL (USA); 4-7 Dec 1989)			
11	15:25978	*See* LBL–26068			
CONF-891204–		(4. international conference on fusion reactor materials; Kyoto (Japan); 4-8 Dec 1989)			
27	15:27339	*See* PNL-SA–17161			
28	15:27338	*See* PNL-SA–16988			
29	15:27337	*See* PNL-SA–16987			
CONF-900109–		(7. symposium on space nuclear power systems; Albuquerque, NM (USA); 7-11 Jan 1990)			
24	15:25841	*See* PNL-SA–17792			
CONF-900115–		(15. workshop on geothermal reservoir engineering; Stanford, CA (USA); 23-25 Jan 1990)			
2	15:25678	*See* LBL–28485			
CONF-900140–		(SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition; Los Angeles, CA (USA); 15-19 Jan 1990)			
16	15:26506	*See* LBL–28483			
17	15:26078	*See* LA-UR–90-965			
18	15:27220	*See* LA-UR–90-768			
CONF-900143–		(Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium; San Francisco, CA (USA); 15-19 Jan 1990)			
32	15:27054	*See* FNAL/C–90/20			
CONF-900156–		(2. international symposium on advanced nuclear energy research - evolution by accelerators; Mito (Japan); 24-26 Jan 1990)			
5	15:25569	*See* LA-UR–90-871			
CONF-900181–		(18. international workshop of the gross properties of nuclei and nuclear excitations; Hirschegg (Austria); 15-20 Jan 1990)			
1	15:27202	*See* LBL–28295			
2	15:27195	*See* BNL–44347			
CONF-900182–		(Computer simulation 1990 multiconference; San Diego, CA (USA); 17-19 Jan 1990)			
1	15:27367	*See* LBL–28275			
CONF-900183–		(Recontres De Moriond '90: new and exotic phenomena; Les Arcs (France); 20-27 Jan 1990)			
1	15:27248	*See* LA-UR–90-1026			
2	15:27076	*See* LA-UR–90-1002			
3	15:27056	*See* LA-UR–90-1014			
CONF-900184–		(American Chemical Society symposium on advances in liquid crystalline polymers; Ventura, CA (USA); 2-6 Jan 1990)			
1	15:26217	*See* LA-UR–90-813			
CONF-900185–		(1990 Aspen winter conference on elementary particle physics; Aspen, CO (USA); 14-20 Jan 1990)			
1	15:27062	*See* FNAL/C–90/48-T			
CONF-900208–		(American Association for the Advancement of Science annual meeting; New Orleans, LA (USA); 15-20 Feb 1990)			
2	15:26654	*See* UCRL–102132			
CONF-900210–		(16. annual waste management symposium: working towards a cleaner environment; Tucson, AZ (USA); 25 Feb - 1 mar 1990)			
36	15:25581	*See* PNL-SA–17315			

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37	15:25611	*See* WSRC-RP–89-830			
38	15:25609	*See* WHC-SA–0708			
39	15:25593	*See* WSRC-RP–89-731			
40	15:25594	*See* WSRC-RP–89-961			
CONF-9002108–		(Workshop on superfund hazardous waste; Arlington, VA (USA); 21-22 Feb 1990)			
1	15:26775	*See* PNL-SA–17907			
CONF-9002109–		(Specialists' meeting on measurement, calculation and evaluation of photon production cross sections; Smolenice (Czechoslovakia); 5-7 Feb 1990)			
1	15:27189	*See* LA-UR–90-1035			
CONF-900212–		(International conference on acidic deposition: state of science and technology; Hilton Head Island, SC (USA); 11-16 Feb 1990)			
1	15:26837	*See* PNL-SA–17635			
CONF-900238–		(SPIE technical conference and exhibition on medical imaging; Newport Beach, CA (USA); 4-9 Feb 1990)			
2	15:26886	*See* LA-UR–90-897			
CONF-900264–		(Topical conference on research trends in nonlinear and relativistic effects in plasmas; San Diego, CA (USA); 5-8 Feb 1990)			
5	15:26492	*See* LBL–28644			
CONF-900276–		(US/Japan workshop on atomic collisions in solids; Honolulu, HI (USA); 2-9 Feb 1990)			
Absts.	15:27211	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008979	MF-411
CONF-900295–		(6. workshop on nuclear dynamics; Jackson Hole, WY (USA); 17-24 Feb 1990)			
1	15:27203	*See* LBL–28579			
2	15:27199	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009317	MF-413
CONF-9003110–		(IAEA international working group on reliability of reactor pressure components; Vienna (Austria); 14-16 Mar 1990)			
1	15:25800	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008569	
CONF-9003115–		(National Society of Black Physicists annual meeting; Baton Rouge, LA (USA); 21-24 Mar 1990)			
1	15:26523	*See* UCRL–100498-Rev.1			
CONF-9003118–		(1. annual conference on cold fusion; Salt Lake City, UT (USA); 28-31 Mar 1990)			
1	15:26365	*See* LA-UR–90-996			
2	15:27254	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009228	MF-400
CONF-9003121–		(Symposium on access security screening: challenges and solutions for the 1990s; New Orleans, LA (USA); 28-30 Mar 1990)			
1	15:26515	*See* LA-UR–90-967			
CONF-9003122–		(Special operations Expo '90; Idaho Falls, ID (USA); 20-22 Mar 1990)			
1	15:27320	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008907	MF-424
CONF-9003123–		(1990 international meeting of the Society for Applied Anthropology; York (UK); 28 Mar - 1 apr 1990)			
1	15:25866	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009231	MF-402
CONF-9003128–		(6. annual review of progress in applied computational electromagnetics; Monterey, CA (USA); 20-22 Mar 1990)			
1	15:27250	*See* SAND–90-0242C			
2	15:27261	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009399	MF-426
CONF-9003129–		(Conference on support for the U.S. environmental and waste management industry by the DOE; Los Alamos, NM (USA); 14 Mar 1990)			
1	15:26528	*See* SAND–90-0737C			
CONF-9003130–		(1990 IEEE conference on artificial intelligence applications; Santa Barbara, CA (USA); 5-9 Mar 1990)			
1	15:27373	*See* PNL-SA–17447			
CONF-9003131–		(Workshop on magnetospheric substroms and solar flares; Honolulu, HI (USA); 26-30 Mar 1990)			
1	15:27021	*See* LA-UR–90-1037			

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CONF-9003133–		(1990 American Society for Testing and Materials; New Orleans, LA (USA); 29-30 Mar 1990)			
1	15:26544	*See* WHC-SA–0642			
CONF-9003134–		(1990 Health Physics Society meeting; Richland, WA (USA); 22 Mar 1990)			
1	15:25610	*See* WHC-SA–0877			
CONF-900315–		(Solar '90: 19th American Solar Energy Society annual conference; Austin, TX (USA); 18-20 Mar 1990)			
1	15:25632	*See* PNL-SA–17859			
2	15:25673	*See* SAND–89-2987C			
CONF-900334–		(3. International Energy Agency heat pump conference; Tokyo (Japan); 12-15 Mar 1990)			
3	15:26019	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008910	MF-350
CONF-900373–		(OSA topical meeting on advanced solid-state lasers; Salt Lake City, UT (USA); 5-7 Mar 1990)			
1	15:26449	*See* UCRL–102248			
CONF-900384–		(American Physical Society meeting; Anaheim, CA (USA); 12-16 Mar 1990)			
1	15:26054	*See* UCRL-JC–103276			
CONF-900396–		(IRIS Specialty Group meeting on passive sensors and atmospheric physics; Laurel, MD (USA); 13 Mar 1990)			
3	15:26537	*See* UCRL-JC–103264			
CONF-900398–		(1990 international conference on neural networks; Lyons (France); Mar 1990)			
1	15:26023	*See* LA-UR–90-515			
CONF-900402–		(199. national meeting of the American Chemical Society; Boston, MA (USA); 22-27 Apr 1990)			
5	15:26223	*See* SAND–89-2565C			
CONF-900403–		(NACE Corrosion '90; Las Vegas, NV (USA); 23-27 Apr 1990)			
9	15:26084	*See* PNL-SA–17601			
CONF-900406–		(International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990)			
54	15:25570	*See* LA-UR–90-1066			
55	15:25572	*See* LBL–28330			
56	15:25577	*See* LBL–28336			
57	15:25571	*See* LBL–28329			
58	15:25573	*See* LBL–28331			
59	15:25576	*See* LBL–28335			
60	15:25575	*See* LBL–28334			
61	15:25596	*See* WSRC-RP–89-1038			
62	15:25574	*See* LBL–28332			
64	15:25583	*See* PNL-SA–17829			
65	15:25582	*See* PNL-SA–17770			
66	15:25514	*See* PNL-SA–17334			
CONF-9004134–		(Field monitoring for a purpose conference; Gothenburg (Sweden); 2-5 Apr 1990)			
3	15:25926	*See* PNL-SA–17848			
CONF-9004136–		(5. IEEE symposium on electromagnetic launch technology; Destin, FL (USA); 1-5 Apr 1990)			
8	15:26505	*See* UCRL—101932			
CONF-9004146–		(16. DOE compatibility, aging and service life conference; Livermore, CA (USA); 24-26 Apr 1990)			
4	15:26087	*See* SAND–90-0782C			
CONF-9004154–		(5. international symposium on advanced technology in welding, materials processing and evaluation; Tokyo (Japan); 17-19 Apr 1990)			
1	15:26130	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009224	MF-404
CONF-9004156–		(1990 SPE California regional meeting; Ventura, CA (USA); 4-6 Apr 1990)			
1	15:25426	*See* LBL–28340			
CONF-9004158–		(International conference on nuclear spectroscopy and shape of atomic nucleus; Leningrad (USSR); 10-13 Apr 1990)			
1	15:27198	*See* LA-UR–90-988			

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CONF-9004159–		(5. distributed memory computing conference; Charleston, SC (USA); 9-12 Apr 1990)			
1	15:27375	*See* SAND–89-2872C			
2	15:26131	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009402	MF-404; MF-405
CONF-9004160–		(34. annual fuze section meeting; San Diego, CA (USA); 4-5 Apr 1990)			
1	15:26556	*See* SAND–89-2427C			
CONF-9004161–		(SAS user group international conference (SUGI-15); Nashville, TN (USA); 1-4 Apr 1990)			
1	15:27355	NTIS, PC A03/MF A01 - OSTI		DE90009242	MF-405
CONF-9004162–		(CHI '90: conference on human factors and computing systems; Seattle, WA (USA); 1-5 Apr 1990)			
1	15:26548	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009240	
CONF-9004163–		(1990 gun and ammunition technical meeting; Annapolis, MD (USA); 5-6 Apr 1990)			
1	15:26553	*See* SAND–89-2344C			
CONF-9004164–		(1. symposium on advances in fatigue lifetime predictive techniques; San Francisco, CA (USA); 25 Apr 1990)			
1	15:26086	*See* SAND–89-1576C			
CONF-900419–		(8. international triennial conference on thin films and the 17th international conference on metallurgical coatings; San Diego, CA (USA); 1-6 Apr 1990)			
	15:26219	*See* N–90-12658			
CONF-900439–		(35. international symposium and exhibition of the Society of the Advancement of Material and Process Engineering: advanced materials, the challenge for the next decade; Anaheim, CA (USA); 2-5 Apr 1990)			
	15:26220	*See* N–90-14294			
CONF-900449–		(ASME international solar energy conference; Miami, FL (USA); 1-4 Apr 1990)			
	15:25662	*See* N–90-14283			
	15:25663	*See* N–90-14285			
	15:25672	*See* N–90-14678			
CONF-900465–		(Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990)			
2	15:26517	*See* LBL–28681			
3	15:26128	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009472	MF-404
CONF-900474–		(ASTM symposium on rapid load fracture testing; San Francisco, CA (USA); 23 Apr 1990)			
1	15:26088	*See* SAND–90-1080C			
CONF-900484–		(26. annual meeting of the National Council on Radiation Protection and Measurements; Washington, DC (USA); 4-5 Apr 1990)			
1	15:26776	*See* PNL-SA–18039			
CONF-900494–		(1990 SCS Eastern multiconference; Nashville, TN (USA); 23-29 Apr 1990)			
3	15:25595	*See* WSRC-RP–89-1026			
4	15:25826	*See* WSRC-RP–89-958			
CONF-9005117–		(GEOVAL '90; Stockholm (Sweden); 14-17 May 1990)			
3	15:25586	*See* SAND–89-2379C			
4	15:26839	*See* SAND–89-2373C			
CONF-9005134–		(2. International conference on computer integrated manufacturing; Troy, NY (USA); 21-23 May 1990)			
1	15:25884	*See* Y/DX–916			
CONF-9005148–		(Integrated contractors meeting and SUBWOG 12A meeting on coatings; Livermore, CA (USA); 8-9 May 1990)			
1	15:26226	*See* UCRL-JC–103223			
CONF-9005149–		(4. national outdoor action conference; Las Vegas, NV (USA); 14-17 May 1990)			
1	15:26538	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008889	
2	15:26841	*See* WSRC-RP–89-1172			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9005151–		(1990 Update for standards in industrial automation: Status and future; St. Louis, MO (USA); 14-16 May 1990)			
1	15:27376	*See* SAND–90-0482C			
CONF-9005152–		(CIMCOM '90: International conference on CIM architecture; Gaithersburg, MD (USA); 22-24 May 1990)			
1	15:27374	*See* SAND–89-2685C			
CONF-9005153–		(Advanced security and identification technologies conference; Washington, DC (USA); 29 May - 1 jun 1990)			
1	15:25616	*See* SAND–90-0863C			
CONF-900530–		(Conference on lasers and electro-optics; Anaheim, CA (USA); 21-25 May 1990)			
3	15:27386	*See* SAND–90-0871C			
CONF-900567–		(1990 international geoscience and remote sensing symposium; College Park, MD (USA); 20-24 May 1990)			
3	15:26514	*See* LA-UR–90-782			
CPS–					
CCME-TS/WM-TRE006E	15:25437	PC National Climatological Information Services, CCAS/I, 4905 Dufferin Street, Downsview, ON, CAN M3H 5T4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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217	15:26027	*See* PB–90-148008/XAB			
476	15:26028	*See* PB–90-159765/XAB			
CRIQ–					
MAT-88-029	15:25637	PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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135	15:26572	NTIS (US Sales Only), PC A03/MF A01		DE90770690	
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3150.6	15:26563	*See* PB–90-156142/XAB			
5030.41	15:25443	*See* PB–90-157389/XAB			
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6050.15	15:25442	*See* PB–90-151804/XAB			
6050.8	15:25872	*See* PB–90-151796/XAB			
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5030.16	15:25901	*See* PB–90-162751/XAB			
5030.55	15:26555	*See* PB–90-157322/XAB			
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T1	15:26045	NTIS (US Sales Only), PC A03/MF A01; OSTI; Imperial College of Science, Technology and Medicine, Department of Mechanical Engineering, Fluids Section, Exhibition Road, London SW7 2BX, UK; GPO Dep.	E 1.99:	DE90009303	MF-361
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DOE/PC/71253–					
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5252	15:26220	*See* N–90-14294			
5253	15:25662	*See* N–90-14283			
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2592-Vol.2	15:25819	*See* NUREG/CR–5513-Vol.2			
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89-06	15:25829	NTIS (US Sales Only), PC A03		DE90764324	
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88-19	15:27323	NTIS (US Sales Only), PC A03/MF A01		DE90706077	

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89-23	15:26020	NTIS (US Sales Only), PC A03/MF A01		DE90764291	
ENEA-RT-PICO–					
89-03	15:25910	NTIS (US Sales Only), PC A05		DE90764318	
ENEA-RT-SAG–					
89-02	15:27208	NTIS (US Sales Only), PC A03		DE90764345	
89-03	15:26893	NTIS (US Sales Only), PC A03/MF A01		DE90764344	
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89-01	15:25921	NTIS (US Sales Only), PC A04/MF A01		DE90764320	
ENEA-RT-TERM–					
89-01	15:26415	NTIS (US Sales Only), PC A07/MF A01		DE90764321	
ENEA-RT-TIB–					
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88-36	15:26435	NTIS (US Sales Only), PC A02/MF A01		DE90764299	
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88-38	15:26437	NTIS (US Sales Only), PC A03/MF A01		DE90764300	
88-40	15:26438	NTIS (US Sales Only), PC A03/MF A01		DE90764301	
88-52	15:26439	NTIS (US Sales Only), PC A03/MF A01		DE90764302	
88-53	15:27359	NTIS (US Sales Only), PC A03/MF A01		DE90764303	
88-54	15:26440	NTIS (US Sales Only), PC A03/MF A01		DE90764305	
89-05	15:26021	NTIS (US Sales Only), PC A03/MF A01		DE90764306	
89-14	15:26348	NTIS (US Sales Only), PC A03/MF A01		DE90764315	
89-15	15:27061	NTIS (US Sales Only), PC A03/MF A01		DE90764295	
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420.560.1	15:25832	NTIS (US Sales Only), PC A04/MF A01		DE90764326	
420.784/2	15:25833	NTIS (US Sales Only), PC A03/MF A01		DE90764280	
440.040/29	15:25680	NTIS (US Sales Only), PC A05/MF A01		DE90764277	
440.950/1	15:25834	NTIS (US Sales Only), PC A02/MF A01		DE90764279	
ENSR-DOCUMENT–					
1200-004-001	15:26618	*See* PB–90-145830/XAB			
EPA–					
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450/3-87/010B	15:26644	*See* PB–90-161514/XAB			
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560/5-89/007	15:26619	*See* PB–90-146291/XAB			
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600/2-89/065	15:25338	*See* PB–90-150830/XAB			
600/4-89/041A	15:26819	*See* PB–90-150863/XAB			
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600/4-89/048A	15:26817	*See* PB–90-150848/XAB			
600/4-89/048B	15:26818	*See* PB–90-150855/XAB			
600/8-89/067F	15:26617	*See* PB–90-145772/XAB			
600/8-89/081	15:26802	*See* PB–90-143496/XAB			
600/8-89/084	15:26816	*See* PB–90-150822/XAB			
600/D-89/152	15:26772	*See* PB–90-142878/XAB			
600/D-89/191	15:26793	*See* PB–90-130956/XAB			
600/D-89/206	15:26609	*See* PB–90-132929/XAB			

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600/D-89/260	15:25315	*See* PB–90-132465/XAB			
600/J-86/521	15:26801	*See* PB–90-142944/XAB			
600/J-89/204	15:26963	*See* PB–90-147802/XAB			
600/J-89/215	15:26942	*See* PB–90-146150/XAB			
600/J-89/216	15:26941	*See* PB–90-146143/XAB			
600/J-89/222	15:26939	*See* PB–90-146085/XAB			
600/J-89/228	15:26938	*See* PB–90-146028/XAB			
600/J-89/236	15:26935	*See* PB–90-143066/XAB			
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02-89/088	15:26821	*See* PB–90-150939/XAB			
02-89/090	15:26823	*See* PB–90-150954/XAB			
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03-89/079	15:26827	*See* PB–90-153693/XAB			
03-89/082	15:26774	*See* PB–90-153743/XAB			
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10-89/019	15:26824	*See* PB–90-150970/XAB			
EPD-DSS–					
89-0074	15:26564	*See* WSRC-RP–89-1443			
EPM/GI–					
RTQ-88-01	15:26048	PC Ministere des transports du Quebec, Direction des communications, 700, boul. St-Cyrille Est,, 18e etage, Quebec, PQ, CAN G1R 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
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87-47(CF)	15:25309	Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab.			
89-47(TR)	15:25256	Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Fuel Processing Lab.			
ERP/ERL–					
89-40(TR)	15:25302	Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Energy Research Labs.			
EUR–					
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12360-EN	15:25375	Commission of the European Communities, (Luxembourg)			
FEW–					
402	15:27368	*See* PB–90-152190/XAB			
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3569	15:25668	NTIS (US Sales Only), PC A07/MF A01		DE90770650	
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3572	15:25661	NTIS (US Sales Only), PC A09/MF A01		DE90770645	
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E62522C-Vol.1	15:26065	PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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GEFR–					
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GGU-R–					
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GKSS–					
89/E/33	15:26577	Reprint from: Komen, G.J.; Oost, W.A. (eds.): Radar scattering from modulated wind waves, Kluwer Academic Publishers (1989), p. 81-88			
89/E/36	15:26784	NTIS (US Sales Only), PC A03/MF A01		DE90767289	
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89/E/41	15:26280	Reprint from: Barrett, C.S.; Gilfrich, J.V.; Jenkins, R.; Huang, T.C.; Predecki, R.K. (eds.): Advances in X-ray analysis, v. 32, Plenum Publishing Corp. (1989), p. 211-220			
89/E/46	15:26068	Reprint from Textures and Microstructures, 1989, v. 10 p. 325-346			
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89/0303	15:25471	*See* PB–90-158312/XAB			
GRS-A–					
1486	15:25797	*See* BMU–1989-225			
HC–					
89-8(Annex)	15:25807	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623080	
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HMRL-R–					
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HN(FP)–					
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IASSNS-HEP–					
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89/51	15:27206	*See* CONF-8908219–1			
90/19	15:27079	*See* CONF-890001–1			
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89/336	15:27232	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622182	
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89/340	15:27234	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622195	
89/341	15:27235	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622169	

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89/346	15:27036	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622298	
89/349	15:27238	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622172	
89/350	15:27037	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622299	
89/351	15:27215	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622340	
89/352	15:27239	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622173	
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89/357	15:27085	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622233	
89/361	15:26299	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622744	
89/362	15:27018	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622483	
89/363	15:27086	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622234	
89/364	15:27241	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622183	
89/366	15:27216	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622341	
89/367	15:27242	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622184	
89/369	15:27066	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622595	
89/373	15:27243	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622175	
89/376	15:26069	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622815	
89/377	15:27217	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622381	
89/383	15:27244	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622176	
89/385	15:27245	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622177	
89/387	15:27038	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622300	
89/393	15:27246	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622178	
89/404	15:27067	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622566	
89/408	15:27087	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622235	
89/413	15:27218	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622342	
89/416	15:27088	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622236	
89/430	15:26580	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622940	
IEA-HPC-R–					
6	15:25976	Available from IEA Heat Pump Center, Eggenstein-Leopoldshafen (Germany, F.R.)			
IEACG–					
CE02992	15:25631	Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST			
IFP–					
37-268	15:26419	NTIS (US Sales Only), PC A09/MF A01		DE90770664	
IFSR–					
408	15:27262	*See* DOE/ET/53088–408			
410	15:27263	*See* DOE/ET/53088–410			
414	15:27264	*See* DOE/ET/53088–414			
417	15:27265	*See* DOE/ET/53088–417			

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IFSR–					
418	15:27266	*See* DOE/ET/53088–418			
420	15:27267	*See* DOE/ET/53088–420			
421	15:27255	*See* DOE/ET/53088–421			
423	15:27268	*See* DOE/ET/53088–423			
425	15:27269	*See* DOE/ET/53088–425			
427	15:27270	*See* DOE/ET/53088–427			
IITRI-E–					
06620-1	15:26961	*See* AD-A–216153/7/XAB			
INDC(NDS)–					
231/L+R	15:27381	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623344	
IOM-TM–					
89-03	15:25350	Institute of Occupational Medicine, Edinburgh (UK)			
89-04	15:25386	Institute of Occupational Medicine, Edinburgh (UK)			
89-09	15:25387	Institute of Occupational Medicine, Edinburgh (UK)			
IPNO-DRE–					
89-20	15:27193	NTIS (US Sales Only), PC A03/MF A01		DE90770340	
IPP–					
III/145	15:27291	NTIS (US Sales Only), PC A03/MF A01		DE90767377	
ISH–					
135	15:26766	Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene			
J–					
00607-1	15:25328	*See* PB–90-148727/XAB			
JAI–					
314	15:25579	*See* ORNL/Sub–86-SA094/6			
JET-R–					
89-11	15:27292	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622425	
JINR–					
13-88-620	15:26539	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623307	
JINR-E–					
4-88-739	15:27247	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622185	
Juel–					
2293	15:25310	NTIS (US Sales Only), PC A06/MF A01		DE90767258	
2298	15:26070	NTIS (US Sales Only), PC A08/MF A01		DE90767358	
2304	15:25513	Available from Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Chemische Technologie der Nuklearen Entsorgung			
2315	15:25562	NTIS (US Sales Only), PC A06/MF A01		DE90767352	
2316	15:25809	NTIS (US Sales Only), PC A04/MF A01		DE90767347	
KAERI/AR–					
299/89	15:26410	NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS		DE90623207	
300/88	15:25532	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90623216	
301/88	15:25533	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90623217	
KAERI/MR–					
140/88	15:26283	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90622736	
150/88	15:27209	NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS		DE90623085	
KAERI/RR–					
713/88	15:25563	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623316	
716/88	15:26364	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90622780	
717/88	15:26533	NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS		DE90623308	
718/88	15:26785	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622935	
719/88/HY	15:25564	NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS		DE90622936	
721/88/ST2	15:26380	NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS		DE90623212	

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722-3/88	15:26076	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90622831	
722/88	15:25565	NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS		DE90623317	
724/88	15:27362	NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS		DE90623348	
728/88	15:25788	NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS		DE90623239	
729/88	15:27039	NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS		DE90622301	
734/88	15:25789	NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS		DE90623349	
735/88	15:25615	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90623193	
741/88	15:25566	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90623311	
744/88	15:25534	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90623218	
748/88	15:26501	NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS		DE90623227	
750/88	15:27207	NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS		DE90622617	
751/88	15:25787	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623236	
754/88	15:26416	NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS		DE90623234	
762/88	15:25773	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90623245	
763/88	15:25793	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90623255	
780/88	15:25567	NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS		DE90623219	
784/88	15:26381	NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS		DE90623223	
787/88	15:25510	NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS		DE90623194	
789/88	15:25568	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90623318	
791/88	15:26300	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90622745	
792/88	15:26382	NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS		DE90623222	
797/88	15:25620	NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS		DE90623202	
798/88	15:25774	NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS		DE90623246	
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803/88	15:25794	NTIS (US Sales Only), PC A17/MF A01; OSTI; INIS		DE90623256	
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613-4074	15:26508	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007965	PC-700
613-4266	15:26383	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007939	PC-701
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4550	15:25810	NTIS (US Sales Only), PC A12/MF A01		DE90767413	
KFK-PEF–					
50-Vol.1	15:26581	NTIS (US Sales Only), PC A17/MF A01		DE90767291	
50-Vol.2	15:26582	NTIS (US Sales Only), PC A18/MF A01		DE90767679	
56	15:26934	NTIS (US Sales Only), PC A13/MF A01		DE90767416	
KI–					
CE02894	15:25977	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
KIB-RUB-TWM–					
89-3	15:26418	Copy held by UB/TIB Hannover			
KNMI-TR–					
119	15:25684	Koninklijk Nederlands Meteorologisch Instituut, P.O. Box 201, 3730 AE De Bilt, Netherlands			
KU-HCOE-FL2-R–					
89-19	15:27219	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622349	

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89-20	15:27227	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622532	
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11558-T	15:26077	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009331	MF-704
11751	15:26562	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007977	MF-700
11757-MS	15:27293	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007976	PC-422
LA-UR–					
90-1002	15:27076	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008917	MF-910
90-1014	15:27056	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008903	MF-910
90-1026	15:27248	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008915	MF-910
90-1035	15:27189	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008906	MF-700
90-1037	15:27021	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008970	MF-702
90-1066	15:25570	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008969	MF-810
90-1113	15:26079	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008967	MF-904
90-378	15:27363	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008860	MF-908
90-515	15:26023	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007539	
90-758	15:26849	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008948	MF-408
90-761	15:27364	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008947	MF-905
90-768	15:27220	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008946	MF-706
90-782	15:26514	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008943	
90-813	15:26217	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008942	MF-704
90-871	15:25569	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008937	MF-700
90-874	15:27019	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008936	
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90-955	15:27366	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008927	MF-910; MF-905
90-965	15:26078	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008924	MF-901; MF-906
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251-89	15:27069	NTIS (US Sales Only), PC A03/MF A01		DE90770259	
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487-067	15:25629	Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST			
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26028	15:26502	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009063	MF-414
26068	15:25978	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009195	MF-350
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27360	15:26146	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009045	MF-404
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27798	15:25979	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009214	MF-402
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28334	15:25575	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009217	MF-403
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908R1	15:25431	*See* AD-A–216036/4/XAB			
LRP–					
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368/89	15:27336	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620732	

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MCHRP–					
88-1	15:26522	*See* PB–90-148735/XAB			
MCR–					
90-01725	15:25743	PC Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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89-05617	15:25636	*See* NBNRE/FM–89-05617			
89-05639	15:25688	*See* VPE–89-05639			
89-05651	15:25656	*See* ADS–55-046			
89-05661	15:26571	*See* CMHC–89-05661			
89-05844	15:25905	*See* BC/CW–89-05844			
89-05977	15:25451	*See* TC/MCI–523F			
89-06063	15:26024	*See* ME–89-06063			
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90-00294	15:25645	*See* EC/WID–90-00294			
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90-14285	15:25663	NTIS, PC A02/MF A01			
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1.15:102406	15:25672	*See* N–90-14678			
1.15:102458	15:25663	*See* N–90-14285			
1.15:102465	15:26220	*See* N–90-14294			
1.15:102473	15:25662	*See* N–90-14283			
NASA-TM–					
102401	15:26219	*See* N–90-12658			
102406	15:25672	*See* N–90-14678			
102458	15:25663	*See* N–90-14285			
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90-133067/XAB	15:25868	NTIS, PC A03/MF A01			
90-136185/XAB	15:26794	NTIS, PC A03/MF A01			
90-137977/XAB	15:26795	NTIS, PC A02/MF A01			
90-138371/XAB	15:26796	NTIS, PC A05/MF A01			
90-138728/XAB	15:26010	NTIS, PC A99/MF A04			
90-141227/XAB	15:26610	NTIS, PC A03/MF A01			
90-141235/XAB	15:26611	NTIS, PC A09/MF A01			
90-141300/XAB	15:25506	NTIS, PC A25/MF A04			
90-141318/XAB	15:25293	NTIS, PC A09/MF A01			
90-141938/XAB	15:26797	NTIS, PC A03/MF A01			
90-142191/XAB	15:25427	NTIS, PC A04/MF A01			
90-142225/XAB	15:25904	NTIS, PC A11/MF A02			
90-142233/XAB	15:25294	NTIS, PC A04/MF A01			
90-142241/XAB	15:25469	NTIS, PC A04/MF A01			
90-142258/XAB	15:25504	NTIS, PC A05/MF A01			
90-142266/XAB	15:25651	NTIS, PC A04/MF A01			

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90-142274/XAB	15:25729	NTIS, PC A06/MF A01			
90-142282/XAB	15:25472	NTIS, PC A06/MF A01			
90-142308/XAB	15:25456	NTIS, PC A03/MF A01			
90-142316/XAB	15:25470	NTIS, PC A03/MF A01			
90-142332/XAB	15:25388	NTIS, PC A08/MF A01			
90-142597/XAB	15:26798	NTIS, PC A03/MF A01			
90-142746/XAB	15:26799	NTIS, PC A06/MF A01			
90-142753/XAB	15:26612	NTIS, PC A06/MF A01			
90-142761/XAB	15:25389	NTIS, PC A06/MF A01			
90-142852/XAB	15:26800	NTIS, PC A03/MF A01			
90-142878/XAB	15:26772	NTIS, PC A02/MF A01			
90-142910/XAB	15:26613	NTIS, PC A03/MF A01			
90-142944/XAB	15:26801	NTIS, PC A03/MF A01			
90-143017/XAB	15:26614	NTIS, PC A03/MF A01			
90-143066/XAB	15:26935	NTIS, PC A03/MF A01			
90-143165/XAB	15:26615	NTIS, PC A03/MF A01			
90-143447/XAB	15:26616	NTIS, PC A11/MF A02			
90-143496/XAB	15:26802	NTIS, PC A03/MF A01			
90-143678/XAB	15:26803	NTIS, PC A02/MF A01			
90-143850/XAB	15:26804	NTIS, PC A03/MF A01			
90-143991/XAB	15:26805	NTIS, PC A02/MF A01			
90-145657/XAB	15:26011	NTIS, PC A08/MF A01			
90-145715/XAB	15:26806	NTIS, PC A04/MF A01			
90-145756/XAB	15:26936	NTIS, PC A05/MF A01			
90-145772/XAB	15:26617	NTIS, PC A15/MF A02			
90-145830/XAB	15:26618	NTIS, PC A10			
90-145954/XAB	15:26937	NTIS, PC A02/MF A01			
90-146028/XAB	15:26938	NTIS, PC A03/MF A01			
90-146085/XAB	15:26939	NTIS, PC A03/MF A01			
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90-146259/XAB	15:26943	NTIS, PC A02/MF A01			
90-146275/XAB	15:26807	NTIS, PC A04/MF A01			
90-146291/XAB	15:26619	NTIS, PC A04/MF A01			
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90-146366/XAB	15:25877	NTIS, PC A03/MF A01			
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90-147273/XAB	15:25352	NTIS, PC A07/MF A01			
90-147281/XAB	15:25318	NTIS, PC A06/MF A01			
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90-147315/XAB	15:25354	NTIS, PC A07/MF A01			
90-147323/XAB	15:25355	NTIS, PC A03/MF A01			
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90-147802/XAB	15:26963	NTIS, PC A01/MF A01			
90-147869/XAB	15:26026	NTIS, PC A06/MF A01			
90-147935/XAB	15:26809	NTIS, PC A19/MF A03			
90-147943/XAB	15:26810	NTIS, PC A15/MF A02			
90-148008/XAB	15:26027	NTIS, PC A14/MF A02			
90-148073/XAB	15:25321	NTIS, PC A02/MF A01			
90-148164/XAB	15:26033	NTIS, PC A07/MF A01			
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90-148255/XAB	15:25356	NTIS, PC A12/MF A02			
90-148289/XAB	15:26951	NTIS, PC A12/MF A02			
90-148420/XAB	15:25357	NTIS, PC A14/MF A02			
90-148461/XAB	15:25869	NTIS, PC A09/MF A01			

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90-148487/XAB	15:25358	NTIS, PC A10/MF A02			
90-148495/XAB	15:25322	NTIS, PC A05/MF A01			
90-148503/XAB	15:25323	NTIS, PC A12/MF A02			
90-148594/XAB	15:25324	NTIS, PC A10/MF A02			
90-148602/XAB	15:25325	NTIS, PC A21/MF A03			
90-148610/XAB	15:25326	NTIS, PC A14/MF A02			
90-148628/XAB	15:25327	NTIS, PC A08/MF A01			
90-148669/XAB	15:27031	NTIS, PC A09/MF A01			
90-148685/XAB	15:25383	NTIS, PC A05/MF A01			
90-148693/XAB	15:26013	NTIS, PC A08/MF A01			
90-148727/XAB	15:25328	NTIS, PC A12/MF A02			
90-148735/XAB	15:26522	NTIS, PC A05/MF A01			
90-148776/XAB	15:25448	NTIS, PC A04/MF A01			
90-148867/XAB	15:25870	NTIS, PC A05/MF A01			
90-148875/XAB	15:26622	NTIS, PC A06/MF A01			
90-148891/XAB	15:25329	NTIS, PC A08/MF A01			
90-148909/XAB	15:25441	NTIS, PC A11/MF A02			
90-148925/XAB	15:25330	NTIS, PC A09/MF A01			
90-148966/XAB	15:25331	NTIS, PC A12/MF A02			
90-148974/XAB	15:25295	NTIS, PC A05/MF A01			
90-148982/XAB	15:25332	NTIS, PC A11/MF A02			
90-149006/XAB	15:26811	NTIS, PC A10/MF A02			
90-149014/XAB	15:25333	NTIS, PC A14/MF A02			
90-149030/XAB	15:25334	NTIS, PC A13/MF A02			
90-149048/XAB	15:25335	NTIS, PC A21/MF A03			
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90-149774/XAB	15:26773	NTIS, PC A08/MF A01			
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90-149832/XAB	15:26952	NTIS, PC A05/MF A01			
90-149840/XAB	15:26813	NTIS, PC A01/MF A01			
90-149972/XAB	15:26624	NTIS, PC A08/MF A01			
90-150459/XAB	15:25359	NTIS, PC A03/MF A01			
90-150467/XAB	15:25336	NTIS, PC A03/MF A01			
90-150491/XAB	15:25337	NTIS, PC A03/MF A01			
90-150574/XAB	15:25360	NTIS, PC A06/MF A01			
90-150756/XAB	15:26625	NTIS, PC A04/MF A01			
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90-150939/XAB	15:26821	NTIS, PC A04/MF A01			
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90-150954/XAB	15:26823	NTIS, PC A04/MF A01			
90-150970/XAB	15:26824	NTIS, PC A06/MF A01			
90-151044/XAB	15:26014	NTIS, PC A04/MF A01			
90-151374/XAB	15:26015	NTIS, PC A16/MF A02			
90-151440/XAB	15:25361	NTIS, PC A13/MF A02			
90-151713/XAB	15:25339	NTIS, PC A16/MF A02			
90-151770/XAB	15:26953	NTIS, PC A06/MF A01			
90-151788/XAB	15:25871	NTIS, PC A04/MF A01			
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90-151804/XAB	15:25442	NTIS, PC A03/MF A01			
90-152190/XAB	15:27368	NTIS, PC A03/MF A01			
90-153107/XAB	15:25340	NTIS, PC A08/MF A01			
90-153156/XAB	15:25362	NTIS, PC A06/MF A01			
90-153180/XAB	15:25341	NTIS, PC A14/MF A02			
90-153271/XAB	15:25342	NTIS, PC A07			
90-153537/XAB	15:25343	NTIS, PC A03/MF A01			
90-153628/XAB	15:25384	NTIS, PC A03/MF A01			
90-153651/XAB	15:25363	NTIS, PC A03/MF A01			
90-153677/XAB	15:26825	NTIS, PC A09/MF A01			
90-153685/XAB	15:26826	NTIS, PC A05/MF A01			
90-153693/XAB	15:26827	NTIS, PC A04/MF A01			
90-153735/XAB	15:26828	NTIS, PC A04/MF A01			
90-153743/XAB	15:26774	NTIS, PC A04/MF A01			
90-153750/XAB	15:26829	NTIS, PC A12/MF A02			
90-153867/XAB	15:26626	NTIS, PC A05/MF A01			

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90-153958/XAB	15:27369	NTIS, PC EE05/MF E05			
90-154121/XAB	15:27370	NTIS, PC EE04/MF E04			
90-154345/XAB	15:27384	NTIS, PC EE05/MF E05			
90-154683/XAB	15:26627	NTIS, PC A03/MF A01			
90-154691/XAB	15:26628	NTIS, PC A03/MF A01			
90-154717/XAB	15:25385	NTIS, PC A03/MF A01			
90-154741/XAB	15:25312	NTIS, PC A03/MF A01			
90-154915/XAB	15:26629	NTIS, PC A08/MF A01			
90-154923/XAB	15:26630	NTIS, PC A04/MF A01			
90-154931/XAB	15:26631	NTIS, PC A06/MF A01			
90-154949/XAB	15:26632	NTIS, PC A06/MF A01			
90-155060/XAB	15:27371	NTIS, PC EE04/MF E04			
90-155359/XAB	15:26083	NTIS, PC A05/MF A01			
90-155425/XAB	15:25364	NTIS, PC A03/MF A01			
90-155557/XAB	15:26633	NTIS, PC A04/MF A01			
90-155565/XAB	15:26634	NTIS, PC A05/MF A01			
90-155573/XAB	15:26635	NTIS, PC A04/MF A01			
90-155615/XAB	15:26830	NTIS, PC A04/MF A01			
90-155664/XAB	15:26636	NTIS, PC A04/MF A01			
90-155870/XAB	15:26411	NTIS, PC A03/MF A01			
90-156142/XAB	15:26563	NTIS, PC A02/MF A01			
90-156183/XAB	15:26554	NTIS, PC A05/MF A01			
90-156233/XAB	15:26831	NTIS, PC A13/MF A02			
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90-157413/XAB	15:26964	NTIS, PC A03/MF A01			
90-157439/XAB	15:25366	NTIS, PC A03/MF A01			
90-157462/XAB	15:25344	NTIS, PC A03/MF A01			
90-157496/XAB	15:26638	NTIS, PC A05/MF A01			
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90-157892/XAB	15:26834	NTIS, PC A03/MF A01			
90-157926/XAB	15:25390	NTIS, PC EE08/MF E08			
90-158312/XAB	15:25471	NTIS, PC A03/MF A01			
90-158338/XAB	15:25460	NTIS, PC A05/MF A01			
90-158346/XAB	15:25461	NTIS, PC A12/MF A02			
90-158403/XAB	15:25346	NTIS, PC A05/MF A01			
90-158742/XAB	15:25473	NTIS, PC A08/MF A01			
90-158973/XAB	15:26639	NTIS, PC A08/MF A01			
90-159070/XAB	15:26036	NTIS, PC A06/MF A01			
90-159245/XAB	15:26835	NTIS, PC A03/MF A01			
90-159260/XAB	15:25878	NTIS, PC A07/MF A01			
90-159450/XAB	15:26640	NTIS, PC A04/MF A01			
90-159740/XAB	15:25347	NTIS, PC A07/MF A01			
90-159765/XAB	15:26028	NTIS, PC A04/MF A01			
90-159831/XAB	15:25730	NTIS, PC A04/MF A01			
90-159898/XAB	15:26641	NTIS, PC A07/MF A01			
90-160045/XAB	15:26642	NTIS, PC A03/MF A01			
90-160078/XAB	15:25462	NTIS, PC A03/MF A01			
90-160326/XAB	15:25430	NTIS, PC A25/MF A04			
90-160409/XAB	15:25348	NTIS, PC A04			
90-160474/XAB	15:25457	NTIS, PC A06/MF A01			
90-160938/XAB	15:26643	NTIS, PC A14/MF A02			
90-161225/XAB	15:25455	NTIS, PC A08/MF A01			
90-161514/XAB	15:26644	NTIS, PC A05/MF A01			
90-161571/XAB	15:26386	NTIS, PC A05/MF A01			
90-161647/XAB	15:25391	NTIS, PC A13/MF A02			
90-161670/XAB	15:26387	NTIS, PC A04/MF A01			
90-161688/XAB	15:26645	NTIS, PC A03/MF A01			
90-162058/XAB	15:26954	NTIS, PC A06/MF A01			
90-162140/XAB	15:25296	NTIS, PC A03/MF A01			
90-162207/XAB	15:25475	NTIS, PC A03/MF A01			
90-162751/XAB	15:25901	NTIS, PC A02/MF A01			
90-162991/XAB	15:25474	NTIS, PC A06/MF A01			
90-163007/XAB	15:25989	NTIS, PC A05/MF A01			
90-501115/XAB	15:26646	NTISCP D01			

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90-501198/XAB	15:25990	NTISCP D01			
90-501206/XAB	15:25991	NTISCP D01			
90-501222/XAB	15:26647	NTISCP D99			
90-856667/XAB	15:26836	NTISPC N01/MF N01			
90-857251/XAB	15:26648	NTISPC N01/MF N01			
90-857426/XAB	15:26649	NTISPC N01/MF N01			
90-857491/XAB	15:25690	NTISPC N01/MF N01			
90-858408/XAB	15:26650	NTISPC N01/MF N01			
90-858556/XAB	15:26049	NTISPC N01/MF N01			
90-858606/XAB	15:26388	NTISPC N01/MF N01			
90-858721/XAB	15:26389	NTISPC N01/MF N01			
90-858747/XAB	15:25449	NTISPC N01/MF N01			
90-858879/XAB	15:25621	NTISPC N01/MF N01			
90-858887/XAB	15:26526	NTISPC N01/MF N01			
90-858929/XAB	15:25618	NTISPC N01/MF N01			
90-859273/XAB	15:26965	NTISPC N01/MF N01			
90-859281/XAB	15:25445	NTISPC N01/MF N01			
90-859331/XAB	15:25750	NTISPC N01/MF N01			
90-859380/XAB	15:26651	NTISPC N01/MF N01			
90-859521/XAB	15:25795	NTISPC N01/MF N01			
90-859588/XAB	15:26895	NTISPC N01/MF N01			
PCCF-T–					
8810	15:27073	NTIS (US Sales Only), PC A08/MF A01		DE90770194	
PEI/E–					
90-01699	15:25446	PC Island Information Service, PO Box 2000, Charlottetown, PE, CAN C1A 7N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
PFC/RR–					
89-18	15:27322	*See* DOE/ET/51013–T225			
PIRSEM–					
2031-1	15:25948	NTIS (US Sales Only), PC A04/MF A01		DE90770656	
3068-1	15:25992	NTIS (US Sales Only), PC A04/MF A01		DE90770658	
PNL–					
5210-Vol.6	15:25770	*See* NUREG/CR–3950-Vol.6			
7172	15:25531	*See* EPRI-NP–6722			
7211	15:25580	*See* ORNL/Sub–89-14384/2			
7245	15:25628	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007989	MF-245
7264	15:27372	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009354	MF-600
PNL-SA–					
16399	15:26652	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009170	MF-502
16987	15:27337	NTIS, PC A03/MF A01; OSTI; INIS		DE90009173	MF-423
16988	15:27338	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009180	MF-423
17161	15:27339	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009172	MF-423
17315	15:25581	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009177	MF-510
17321	15:26896	NTIS, PC A02/MF A01 - OSTI		DE90008634	MF-220
17334	15:25514	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009456	MF-812
17447	15:27373	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009179	MF-505; MF-506
17601	15:26084	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008623	MF-404
17635	15:26837	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009174	MF-402
17770	15:25582	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009455	MF-812
17792	15:25841	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008676	MF-528
17829	15:25583	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009454	MF-810
17848	15:25926	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009450	MF-350
17859	15:25632	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009175	MF-920
17907	15:26775	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009171	
18039	15:26776	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009451	MF-507
PPPL–					
2683	15:27312	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007942	PC-426
2684	15:27313	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007947	PC-427
2687	15:27314	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007946	PC-426; PC-427
PSR–					
1864	15:27030	*See* AD-A–216260/0/XAB			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
QER–					
90-01666	15:25860	PC Ministere de l'energie et des ressources, Direction des communications, 200, chemin Sainte-Foy, 7e etage, Quebec, PQ, CAN G1R 4X7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
QME–					
PA-29	15:26838	PC Que@'bec Ministe@'re de l'environnement, 3900, rue Marly, Ste Foy, PQ, CAN G1X 4E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
RAL–					
89-111	15:27032	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90619482	
89-113	15:27074	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622555	
89-122	15:26504	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623229	
89-126	15:27075	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622569	
RCM–					
CE02982	15:26037	Recycling Council of Manitoba, 1329 Niakwa Road East, Winnipeg, MB, CAN R2J 3T4. Prices: PRICES UPON REQUEST			
REPT–					
89-2Q	15:25506	*See* PB–90-141300/XAB			
RFP–					
4247	15:26534	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007971	PC-706
4256	15:26085	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007972	PC-704
4279	15:26527	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007970	PC-706
RISO-M–					
2731	15:27223	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90622351	
RR–					
125-8	15:26011	*See* PB–90-145657/XAB			
RT/COMB–					
88-3	15:25512	*See* ENEA-RT-COMB–88-03			
88-9	15:25614	*See* ENEA-RT-COMB–88-09			
89-2	15:26276	*See* ENEA-RT-COMB–89-02			
89-12	15:25560	*See* ENEA-RT-COMB–89-12			
89-13	15:26414	*See* ENEA-RT-COMB–89-13			
89-14	15:25561	*See* ENEA-RT-COMB–89-14			
RT/DISP–					
88-5	15:25619	*See* ENEA-RT-DISP–88-05			
88-6	15:26962	*See* ENEA-RT-DISP–88-06			
89-05	15:25804	*See* ENEA-RT-DISP–89-05			
89-6	15:25829	*See* ENEA-RT-DISP–89-06			
89-07	15:26764	*See* ENEA-RT-DISP–89-07			
RT/FARE–					
89-3	15:25683	*See* ENEA-RT-FARE–89-03			
RT/FUS–					
87-37	15:27271	*See* ENEA-RT-FUS–87-37			
88-15	15:27272	*See* ENEA-RT-FUS–88-15			
88-16	15:27273	*See* ENEA-RT-FUS–88-16			
89-7	15:27290	*See* ENEA-RT-FUS–89-07			
RT/PAS–					
89-4	15:26901	*See* ENEA-RT-PAS–89-04			
89-17	15:26032	*See* ENEA-RT-PAS–89-17			
89-23	15:26020	*See* ENEA-RT-PAS–89-23			
RT/PICO–					
89-3	15:25910	*See* ENEA-RT-PICO–89-03			
RT/SAG–					
89-2	15:27208	*See* ENEA-RT-SAG–89-02			
89-3	15:26893	*See* ENEA-RT-SAG–89-03			
RT/STUDI–					
89-1	15:25921	*See* ENEA-RT-STUDI–89-01			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
RT/TERM–					
89-1	15:26415	*See* ENEA-RT-TERM–89-01			
RT/TIB–					
87-67	15:27358	*See* ENEA-RT-TIB–87-67			
88-36	15:26435	*See* ENEA-RT-TIB–88-36			
88-37	15:26436	*See* ENEA-RT-TIB–88-37			
88-38	15:26437	*See* ENEA-RT-TIB–88-38			
88-40	15:26438	*See* ENEA-RT-TIB–88-40			
88-52	15:26439	*See* ENEA-RT-TIB–88-52			
88-53	15:27359	*See* ENEA-RT-TIB–88-53			
88-54	15:26440	*See* ENEA-RT-TIB–88-54			
89-5	15:26021	*See* ENEA-RT-TIB–89-05			
89-14	15:26348	*See* ENEA-RT-TIB–89-14			
89-15	15:27061	*See* ENEA-RT-TIB–89-15			
89-18	15:26442	*See* ENEA-RT-TIB–89-18			
89-19	15:27213	*See* ENEA-RT-TIB–89-19			
89-21	15:26443	*See* ENEA-RT-TIB–89-21			
89-22	15:26132	*See* ENEA-RT-TIB–89-22			
89-23	15:26060	*See* ENEA-RT-TIB–89-23			
89-28	15:26444	*See* ENEA-RT-TIB–89-28			
89-29	15:26576	*See* ENEA-RT-TIB–89-29			
89-37	15:26277	*See* ENEA-RT-TIB–89-37			
89-40	15:26278	*See* ENEA-RT-TIB–89-40			
89-41	15:27051	*See* ENEA-RT-TIB–89-41			
89-43	15:26211	*See* ENEA-RT-TIB–89-43			
89-46	15:26844	*See* ENEA-RT-TIB–89-46			
89-47	15:27360	*See* ENEA-RT-TIB–89-47			
RTI/TIB–					
89-30	15:27332	*See* ENEA-RTI-TIB–89-30			
SAND–					
2612/Pt.A	15:25459	NTIS, PC A20/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007948	MF-132
87-8215B	15:26222	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007953	MF-701
88-0811	15:25584	NTIS, PC A12/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007951	MF-814
88-1078-Rev.	15:27385	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008650	MF-900
88-2997	15:25585	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007950	MF-814
88-3188	15:26446	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007960	MF-706
89-0855	15:26541	NTIS, PC A03/MF A01 - OSTI		DE90007913	MF-706
89-1089	15:26542	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007959	MF-406
89-1302	15:25601	*See* NUREG/CR–5381			
89-1483C	15:27340	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009352	MF-712
89-1576C	15:26086	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008957	MF-704
89-2064	15:27316	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008033	PC-420; PC-421; PC-422; PC-423
89-2344C	15:26553	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008678	MF-700
89-2368	15:25816	*See* NUREG/CR–5460			
89-2373C	15:26839	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009307	MF-721
89-2379C	15:25586	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009286	MF-721
89-2427C	15:26556	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009006	MF-700
89-2565C	15:26223	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009281	MF-701
89-2612/Pt.B	15:25458	NTIS, PC E16/MF E04 - OSTI; GPO Dep.	E 1.99:	DE90007938	MF-132
89-2685C	15:27374	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008677	MF-705
89-2872C	15:27375	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008999	MF-405
89-2894	15:25401	NTIS, PC A03/MF A01 - OSTI		DE90007899	MF-126
89-2987C	15:25673	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009007	MF-275
90-0021	15:26557	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007952	MF-900
90-0242C	15:27250	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008804	MF-705
90-0482C	15:27376	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008803	MF-705
90-0737C	15:26528	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008806	MF-706
90-0782C	15:26087	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009285	MF-704
90-0863C	15:25616	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008679	MF-700
90-0871C	15:27386	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009351	MF-705
90-1080C	15:26088	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009510	MF-704; MF-705
SCBCS–					
90-01592	15:25913	PC Saskatchewan Power Corporation, 2025 Victoria Ave., Regina, SK, CAN S4P 0S1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
SCIENTIFIC–					
4	15:27017	*See* AD-A–216380/6/XAB			
SDK–					
3509-01	15:25823	NTIS (US Sales Only), PC A04/MF A01		DE90767249	
SEMR–					
9	15:26038	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
10	15:26039	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
20	15:25993	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
33	15:25367	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
36	15:26040	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
38	15:26041	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
39	15:26042	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
FP-13	15:25994	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
SERI/TP–					
211-3656	15:25652	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000314	MF-271
211-3667	15:25653	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000320	MF-271
SGD–					
542-PT-1	15:27031	*See* PB–90-148669/XAB			
SIS–					
1989:4	15:25824	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623063	
1989:5	15:26653	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622943	
1989:6	15:26966	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90623061	
SMU-G–					
6	15:26551	*See* AD-A–216218/8/XAB			
SOL–					
90-7	15:27377	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009755	MF-405
SOQUIP–					
90-01060	15:25914	PC SOQUIP (Societe quebecoise d'initiatives petrolieres), 1175, rue de Lavigerie, C.P. 10650, Ste-Foy, PQ, CAN G1V 4P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
SWEG–					
36	15:25995	Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
37	15:25996	Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
38	15:25997	Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
39	15:25998	Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
40	15:25999	Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
SWRI–					
8673	15:26643	*See* PB–90-160938/XAB			
TA–					
269	15:25978	*See* LBL–26068			
TC/MCI–					
523E	15:25450	PC Transport Canada, Library and Information Centre, Place de Ville, Tower C, Ottawa, ON, CAN K1A 0N5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
523F	15:25451	PC Transport Canada, Library and Information Centre, Place de Ville, Tower C, Ottawa, ON, CAN K1A 0N5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
TM–					
89/05	15:25390	*See* PB–90-157926/XAB			
TNO-HMT–					
88-145-Vol.1	15:25686	Hoofdgroep Maatschappelijke Technologie TNO, P.O. Box 342, 7300 AA Apeldoorn, Netherlands			
88-145-Vol.2	15:25687	Hoofdgroep Maatschappelijke Technologie TNO, P.O. Box 342, 7300 AH Apeldoorn, Netherlands			
89-093	15:25927	Hoofdgroep Maatschappelijke Technologie TNO, P.O. Box 342, 7300 AH Apeldoorn, Netherlands			
TPC–					
90-00527	15:25679	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN			
TR–					
0086A(2930-06)1	15:26431	*See* AD-A–216409/3/XAB			
18-ONR	15:25845	*See* AD-A–216030/7/XAB			
19-ONR	15:25847	*See* AD-A–216038/0/XAB			
20-ONR	15:25846	*See* AD-A–216037/2/XAB			
UBA-FB–					
81-121-Vol.3	15:26604	*See* NILU/OR–43/89			
81-121-Vol.4	15:26603	*See* NILU/OR–26/89			
UBUFFALO/DC–					
89/TR-4	15:27226	*See* AD-A–216393/9/XAB			
UCID–					
21791-3	15:26493	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007937	
21832	15:25587	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010204	MF-510
21870	15:26559	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007921	MF-703
21936	15:26447	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007925	MF-706
21938	15:26448	NTIS, PC A03/MF A01 - OSTI		DE90007923	MF-706
21966	15:26535	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007926	MF-700
UCRL–					
-101932	15:26505	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009183	MF-706
100099	15:25588	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009188	MF-703
100125	15:26224	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009187	MF-706
100498-Rev.1	15:26523	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009181	MF-706
102045	15:26777	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009289	MF-402
102132	15:26654	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009032	MF-702
102248	15:26449	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009542	MF-410
102937	15:26536	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008913	MF-706
53918	15:27378	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007929	MF-405
53947	15:26089	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007975	MF-701
99806	15:26543	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009189	MF-706
UCRL-CR–					
103295	15:27224	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009475	MF-700

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UCRL-ID–					
103119	15:27317	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007958	MF-420
103120	15:26029	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010205	MF-702
103133	15:26052	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007930	MF-400
103137	15:26558	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007928	MF-703
103170	15:27204	NTIS, PC A03/MF A01; GPO Dep.	E 1.99:	DE90010203	MF-700
103234	15:26450	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010206	MF-706
103307	15:26225	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007931	MF-706
103333	15:26494	NTIS, PC A05/MF A01 - OSTI		DE90007936	
UCRL-JC–					
103152	15:26495	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009004	
103223	15:26226	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009190	MF-704
103264	15:26537	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009182	MF-706
103276	15:26054	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009185	MF-701; MF-706
103340	15:26284	NTIS, PC A02/MF A01 - OSTI		DE90009184	MF-704
UIUC-HEPG–					
90-39	15:27053	*See* DOE/ER–3072-54			
ULS-FSAR–					
001	15:26007	*See* NUS–5249			
002	15:26004	*See* DOE/ET/32043–T31-Vol.1			
003	15:26005	*See* DOE/ET/32043–T31-Vol.2-Bk.1			
005	15:26008	*See* NUS–5250-Vol.3-BK.1			
006	15:26009	*See* NUS–5250-Vol.3-BK.2			
UNC/GJ–					
50(TMC)	15:25971	*See* DOE/ID/12584–57			
51(TMC)	15:26512	*See* DOE/ID/12584–61			
UPWS-DS–					
84	15:26894	*See* PB–90-146473/XAB			
USGS/WRI–					
83-4014	15:25322	*See* PB–90-148495/XAB			
USNA-TSPR–					
159	15:26509	*See* AD-A–216267/5/XAB			
UT/BEG–					
90008973	15:25402	OSTI; Bureau of Economic Geology, University of Texas at Austin, Austin, TX 78713		TI90008973	
UTD-GRL–					
8902	15:26426	*See* AD-A–216008/3/XAB			
UTHEP–					
89-0901	15:27065	*See* IC–89/261			
89-0902	15:27064	*See* IC–89/260			
VPE–					
89-05639	15:25688	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
Vejdatalaboratoriet-R–					
62	15:26655	Available on loan from Risoe Library, DK-4000 Roskilde			
WES/TR/SL–					
89-17	15:25535	*See* AD-A–215831/9/XAB			
WHC-EP–					
0042	15:25589	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007935	MF-603
0219-Rev.1	15:25590	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007963	MF-902
0282	15:27205	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008126	MF-603
WHC-SA–					
0642	15:26544	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009133	MF-506
0708	15:25609	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009334	MF-721
0877	15:25610	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009134	MF-900
WRDC-TR–					
89-1149	15:26547	*See* AD-A–216308/7/XAB			
WSL-LR–					
716(PA)M	15:26656	Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
WSRC-RP–					
89-1026	15:25595	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009116	MF-701
89-1038	15:25596	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009249	MF-721

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89-1085	15:26840	NTIS, PC A13/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008007	PC-703
89-1172	15:26841	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009275	MF-702
89-1198	15:25796	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009250	MF-702
89-1223	15:25827	NTIS, PC A03/MF A01 - OSTI		DE90009294	MF-705
89-1311	15:25828	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009277	MF-706
89-1379	15:25597	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009066	MF-702
89-1443	15:26564	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009259	MF-700
89-1445	15:25612	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009255	MF-702
89-321	15:25591	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009122	MF-721
89-485	15:25592	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009254	MF-706
89-683	15:25556	*See* DOE/SR/18035–P-H1			
89-731	15:25593	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008898	MF-721
89-770	15:25825	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009302	MF-706
89-815	15:25792	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009117	MF-702
89-816	15:26778	NTIS, PC A99/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009274	MF-702
89-830	15:25611	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009131	MF-702
89-958	15:25826	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009293	MF-706
89-961	15:25594	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009143	MF-721
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728	15:27347	*See* AD-A–215805/3/XAB			
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637	15:26417	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623235	

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